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Agricultural Adjustment Administration
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INTRODUCTION

The Agricultural Adjustment Administration has considered, from time to time, a number of different methods of removing surplus eggs from the normal channels of trade and commerce in order to relieve producers of burdensome supplies which tend to depress farm prices. One of the methods considered was that of making benefit payments to domestic egg-drying firms in order to divert surplus shell eggs into dried-egg products.[1]

It was found, however, that this method of surplus removal was considerably complicated by questions of international trade, by the relationship of dried eggs to shell and frozen eggs, by the intricacies of the egg-drying industry in itself, and by the fact that practically no information was available on these subjects which would be pertinent to the consideration of such a program. A study was therefore initiated which would furnish information on the past development of the domestic and foreign egg-drying industry, the available facilities in this country for drying egg products, the factors which have influenced imports of dried-egg products, costs of producing these products, the degree of competition between dried eggs and frozen or shell eggs, and the uses for dried eggs. Since the information which was gathered is of general interest and to a considerable extent was obtained from primary sources, it has been deemed worthwhile to make it available to the public.

HISTORY AND DESCRIPTION OF THE EGG-DRYING INDUSTRY

EARLY HISTORY IN THE UNITED STATES AND CHINA

After 1860 the production and marketing of poultry products became a significant commercial enterprise in the United States as a result of the shifting of farm population to urban centers, the advent of improved means of transportation, and the mechanical incubation of baby chicks. Since liquid egg contains about 75 percent water, and the shell of an egg is a fragile container, there naturally existed a desire to transform shell eggs into some more compact and

[1] Such a program was considered in connection with sec. 32 of the 1935 amendments to the Agricultural Adjustment Act, which reads in part: "There is hereby appropriated for each fiscal year beginning with the fiscal year ending June 30, 1936, an amount equal to 30 per centum of the gross receipts from duties collected under the custom laws during the period January 1 to December 31, both inclusive, preceding the beginning of each such fiscal year. Such sums shall be maintained in a separate fund and shall be used by the Secretary of Agriculture only to * * * (2) encourage the domestic consumption of such commodities or products by diverting them, by the payment of benefits or indemnities or by other means, from the normal channels of trade and commerce." The program was not approved for reasons indicated by this study.

less perishable form. As cold storage by mechanical methods and the freezing of liquid eggs had not been perfected,[2] efforts were made to reduce the costs of handling and holding the surplus spring eggs by various dehydration processes. Desiccated eggs also offered other advantages, such as the possibility of increasing the value of eggs which had unsatisfactory exterior qualities and the opportunity of preventing loss due to breakage.

Patents were sought in the United States as early as 1865 for various methods of drying eggs. Charles A. LaMont was probably the first inventor of such a process, but there is no record of his actually operating an egg-drying plant until about 1878. One reference states [3] that in 1878 a St. Louis, Mo., firm was transforming egg yolk and albumen, by a drying process, into a light brown, meal-like substance. It reports that this product, after storage for a year, made as good cakes, omelets, etc., as fresh eggs and that subjection to heat and long sea voyages did not result in deterioration of the product. W. O. Stoddard, another early inventor of machinery and processes for drying eggs, also operated an egg-drying plant in St. Louis about this same time.

In spite of the optimism expressed for this new form of eggs, drying must have continued only on a small scale until near the turn of the century. However, from 1895 to 1905 the egg-drying industry made rapid advances in this country; a number of plants began operations, and dried eggs were shipped to Alaska and even to China for the use of the United States Army there. By 1903 Mr. LaMont, whose operations had been transferred to Chicago, had active competition from at least five other companies which had come into the business during the previous 5 years. Four of these were located in Missouri and one in Sioux City, Iowa.

As the industry expanded, some difficulty arose with governmental regulatory bodies regarding the quality of the products sold. In 1905 the Massachusetts Board of Health claimed that certain firms used formaldehyde to destroy the offensive smell in rotten and stale eggs used in manufacturing a dried product sold as being derived wholly from good quality eggs.[4] Notices of Judgment by the United States Department of Agriculture for cases under the Food and Drug Act began to appear in 1909, and in 1910 there were no less than 14 such judgments. The Iowa Wholesale Butter and Egg Dealers Association in 1911 sent the following telegram to the Secretary of Agriculture: [5]

> At our annual convention which was held today, motion to endorse Lodge amendment to House amendment 31596 providing for factory inspection of canned and dried eggs was unanimously carried. We request your hearty cooperation in support of this motion which is of vital importance to Iowa producers and egg dealers.

In September 1912, the United States Department of Agriculture issued a bulletin [6] dealing with bacteriological examinations of samples of frozen and desiccated eggs collected from shipments entering interstate commerce. Many instances of high bacterial content

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[2] The Cold Storage of Eggs and Poultry. Circular No. 73, U. S. Department of Agriculture, Washington, D. C., Revised May 1938.
[3] The American Poultry Yard, February 16, 1878.
[4] The Egg Reporter, September 20, 1905.
[5] The Egg Reporter, March 6, 1911.
[6] A Bacteriological Study of Shell, Frozen, and Desiccated Eggs, U. S. Bu. of Chem. Bull. No. 158. G. W. Stiles and C. Bates.

and adulterated products were reported since the product "consists in whole or in part of filthy, decomposed, or putrid animal or vegetable substance." Food and Drug Administration officials continued seizures of desiccated eggs as unfit for food through 1914.

It appears that the domestic egg-drying industry began to disintegrate in the latter part of 1915. This was about the time that egg prices, along with prices of other products, began rising sharply, and it was chiefly these higher prices that caused a large part of the egg-drying industry to move to China. The difficulties which the industry had had with governmental agencies because of unsatisfactory products might also have had some effect on the volume of domestic dried-egg production. In addition, the opening of the Panama Canal aided the growth of Chinese exports of egg products to the United States by permitting cheaper shipping to the Atlantic seaboard, and the war in Europe brought not only high shell-egg prices but also higher labor costs in this country.

While the drying of eggs in China had begun when German engineers built drying equipment there just prior to the beginning of the century, only a small quantity of dried eggs were exported to the United States before 1915. The Bureau of Foreign and Domestic Commerce reported 5,555 pounds of dried eggs imported during 1912 and 20,284 pounds in 1913. A member of the egg-drying industry has written [7] that there were two factories near Nanking on the Yangtze River in 1897, four in Hankow in 1898, and that by 1920 there were a score using foreign machinery and several hundred of the native style. Several American firms erected factories in China between 1915 and 1920, including the Amos Bird factory which was established in Shanghai and the National Bakers' Egg Co. which had formerly operated at Sioux City, Iowa. The capacity of the plants built in China ranged from 500 to 24,000 pounds of finished product a day.

While this development was going on in China the industry in the United States was practically dormant. A number of attempts were made to dry eggs on machinery primarily designed for the drying of milk, but these were unsuccessful because of unfavorable price relationships, and the imports of dried and frozen eggs from China increased at a very rapid rate.[8] During the years 1915–16 and 1916–17 (fiscal years ending June 30) imports of dried and frozen eggs from China averaged about 6,000,000 pounds annually, and in the 3 years 1917–18, 1918–19, and 1919–20, these imports had increased to an average of about 10,000,000 pounds annually. During 1920–21 and 1921–22 imports had further increased to about 24,000,000 pounds. In September 1922, a tariff of 18 cents a pound on dried eggs and 6 cents on frozen eggs went into effect and, at least partially as a result of this change in the tariff, imports from China decreased. During the next 3 years imports averaged less than 15,000,000 pounds annually, but were still larger than during the war years and were decidedly larger than imports prior to the war.

While most of the dried eggs consumed in the country were being produced in China, a number of attempts were made to limit

[7] Cole, R. J. Egg Albumen. Food Manufacturing, vol. 8, pp. 401–403, 1933.

[8] No official figures are available for United States imports of dried eggs as distinct from frozen eggs prior to 1921.

or place an embargo on these imports. Oregon, Washington, and California passed laws in 1915 which required that foreign eggs be labeled as such, and also required the posting of a sign in places where these products were offered for sale stating that "Imported eggs are used here" or "We use foreign eggs." In 1916 the University of Oregon issued a publication [9] in which it was contended that Chinese eggs and egg products were inferior to domestically produced eggs, and that these egg products could be produced in the United States were it not for Chinese competition. The National War Emergency Poultry Federation, organized in 1918, had the curtailment of dried-egg imports as one of its major objectives; and in 1921, the American Poultry Association presented a brief recommending increased tariffs. As a result of these efforts the tariff was increased in September 1922.

In 1925 the Poultry Producers of Central California Cooperative Association began manufacturing some dried eggs, but in the annual report covering its operations for the year 1926, the manager stated, "The association has definitely decided that it cannot dry eggs in competition with the imported product."

THE INDUSTRY IN THE UNITED STATES SINCE 1927

After the disintegration of the egg-drying industry of this country in 1915–16 it was not until civil war conditions developed in China in 1927, thereby curtailing Chinese exports, that egg-drying operations on a commercial scale were again attempted in this country. Imports of dried yolk, albumen, and whole egg declined more than 3,000,000 pounds in 1927 as compared to 1926. The year 1928 witnessed a rather large expansion in the number and the total drying capacity of plants in this country. Two plants had begun operations in 1927, two more in 1928, and an additional plant drying albumen was established in 1929. However, the total production of these plants was small until declining egg prices in 1930 and 1931 resulted in a more favorable competitive relationship with Chinese prices.

On July 24, 1931, following a study made by the Tariff Commission,[10] the tariff on dried-egg products was increased the full 50 percent allowed by law, from 18 cents to 27 cents per pound, by Presidential proclamation. This tariff increase, together with further declines in domestic egg prices, caused an even greater expansion in the domestic production of both dried albumen and yolk. While the domestic industry prior to the time it moved to China, in about 1915, was engaged principally in producing dried whole egg, it was now mainly interested in drying yolk and albumen separately, as is indicated by the figures in table 1. This tendency was probably due to the fact that the egg-drying equipment had been considerably improved as compared to the earlier machinery, and to the changing national food habits from home-prepared to factory-prepared pastries, etc.

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[9] Chinese Eggs. School of Commerce, University of Oregon, Salem, Oreg. J. Frederic Thorne. See pp. 5 and 39.

[10] Report to the President on Dried Egg Products. Report No. 25, second series, June 16, 1931.

TABLE 1.—*Estimated U. S. production of dried-egg products, in pounds, and shell-egg equivalents, in dozens* [1]

Year	Yolk	Albumen	Whole egg	Total	Shell-egg equivalents [2]	Additional dried products which could be produced from surplus liquid eggs [2]	
						Yolk	Albumen
	Pounds	*Pounds*	*Pounds*	*Pounds*	*1,000 dozens*	*1,000 pounds*	*1,000 pounds*
1927	395,127	----------	160,900	556,027	2,148	----------	145
1928	214,683	2,500	----------	217,183	900	----------	77
1929	189,409	10,000	3,000	202,409	803	----------	60
1930	481,808	----------	7,257	489,065	2,041	----------	177
1931	478,456	1,770	72,517	552,743	2,227	----------	174
1932	1,868,607	401,738	14,638	2,284,983	7,874	----------	286
1933	2,170,598	1,486,715	55,572	3,712,885	17,089	1,867	----------
1934	2,668,237	1,419,075	286,138	4,373,450	17,025	1,186	----------
1935	2,805,502	133,357	61,414	3,000,273	11,943	----------	900
1936	1,026,686	256,507	77,169	1,360,362	4,538	----------	122
1937	1,776,393	549,822	74,400	2,400,615	7,671	----------	104

Production figures as reported by 11 manufacturers. So far as can be learned, these firms represent all of the domestic egg driers with the possible exception of 1 or 2 which may have done a small amount of experimental drying. In the case of 1 firm, production is estimated.

[2] In determining the shell-egg equivalents, conversion factors as presented on p. 18 were used. However, these shell-egg equivalents cannot be totaled since the same shell eggs can be used for producing both dried albumen and dried yolk and yet there is always a surplus of either yolk or albumen which is not dried. For example, in 1934 there was dried in the United States the albumen equivalent of 16,149,074 dozen eggs, but the yolk equivalent of only 11,179,913 dozen. This meant that there was a surplus of liquid yolk which was not dried (probably sold in frozen form) of more than 2,500,000 pounds. This liquid yolk could have made more than 1,000,000 pounds of dried yolk and the total volume of dried eggs produced in the year could have been this much larger without increasing the total shell-egg equivalents as shown in the table. Therefore, in computing the total figure the shell-egg equivalent of the dried whole egg has been added to the largest shell-egg equivalent of either the yolk or albumen. Another column of figures is shown which is the number of pounds of either dried yolk or albumen that could have been produced without increasing the computed shell-egg equivalents.

The domestic production of dried-egg products, expanding as the general business depression deepened, reached a peak in 1933 and 1934. Table 1 shows the domestic production of dried-egg products from 1927 through 1937, in pounds, and in shell-egg equivalents.

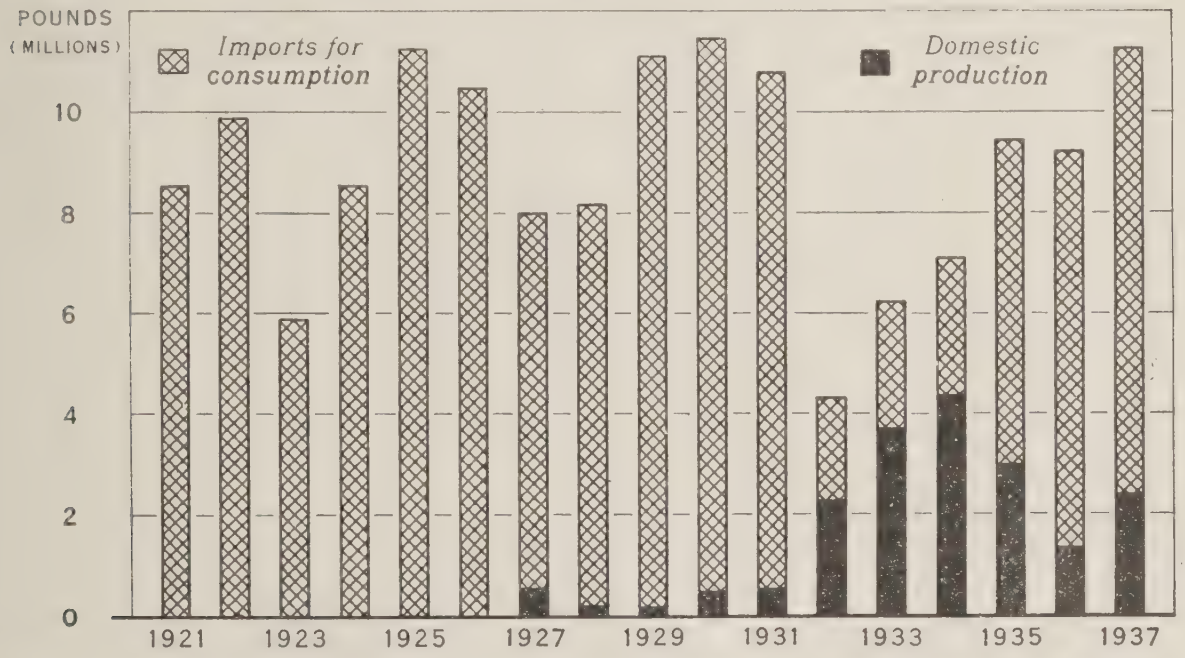

FIGURE 1.—Domestic production and imports for consumption of dried-egg products, 1921–37. The total supplies of dried eggs in the United States have fluctuated from a little more than 4,000,000 to nearly 11,500,000 pounds since 1921. From 1932 through 1934 domestically produced dried eggs made up a considerable proportion of the reduced supplies of dried-egg products. See table I in appendix A.

As the production decreased in 1935 and 1936, the imports of dried-egg products from China increased. The changing relationship be-

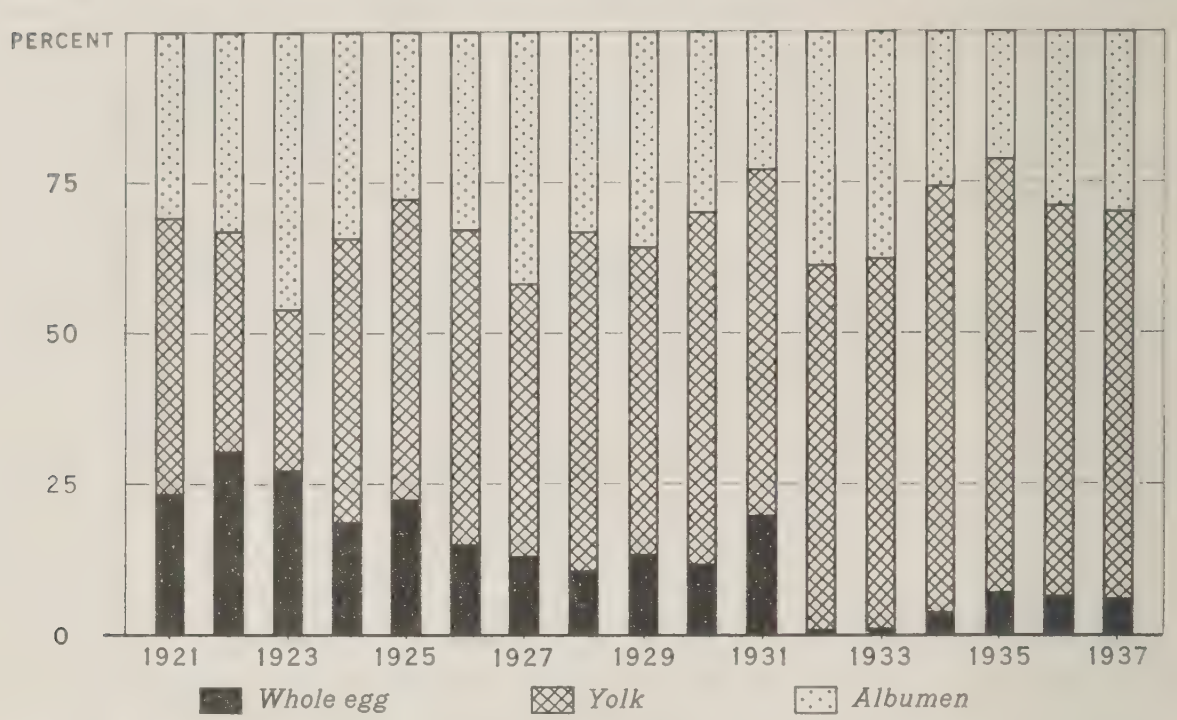

FIGURE 2.—Domestic production and imports for consumption of dried-egg products—percent whole egg, yolk, and albumen is of the total supply, 1921–37. Except for 1 year, dried yolk has been the most important dried-egg product used in the United States. This has been increasingly true as the use of dried whole egg has declined. See table II in appendix A.

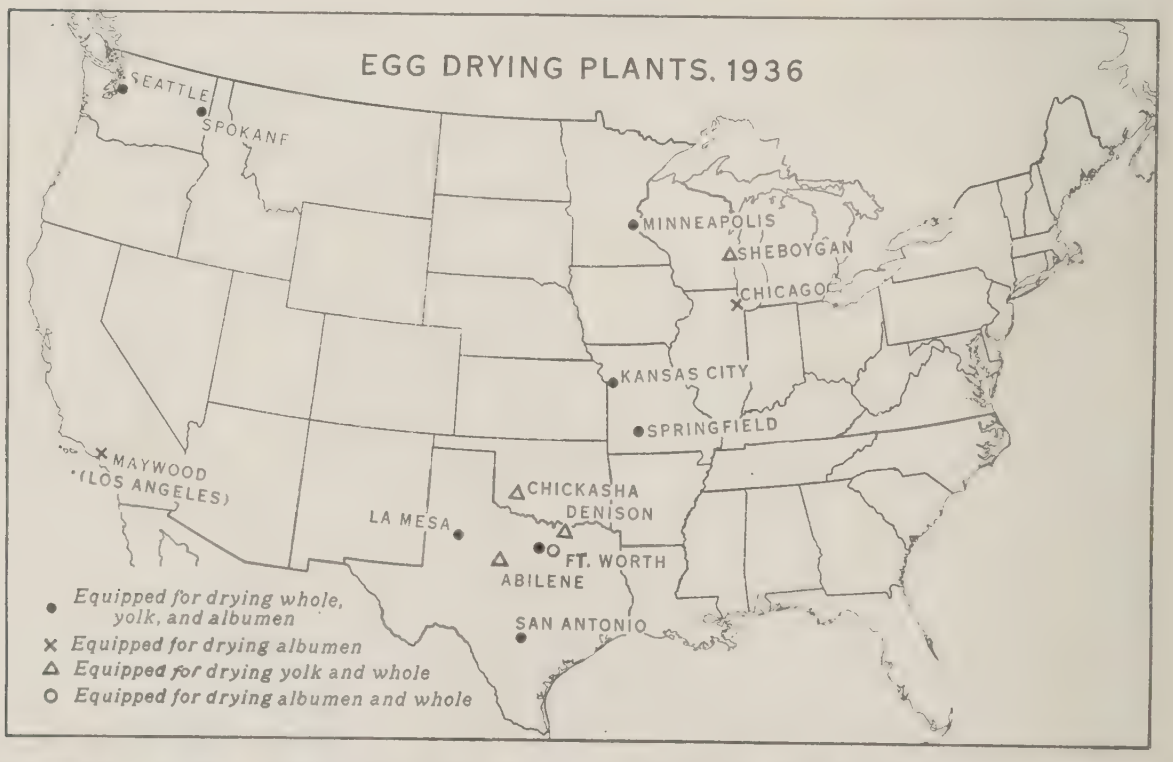

FIGURE 3.—A few egg-drying plants are located on the Pacific coast, but most of them are centered in the surplus egg production sections of the Middle West, with a particular concentration in the State of Texas.

tween imports and domestic production is indicated in table 2 and figure 1, which show imports and domestic production of dried-egg products in shell-egg equivalents from 1921 through 1937. Figure 2

shows the proportion of total dried-egg supplies which have been represented by whole egg, yolk, and albumen during the same period.

No additions have been made to existing plant capacity since 1934, and a number of the plants formerly used for egg-drying purposes have been idle during the past 3 years. The industry itself is small, but most of the firms comprising it represent fairly large-scale enterprises—egg-breaking establishments, cooperative marketing associations, meat packers, and importers. Usually the production of dried-egg products is only incidental to other operations of these firms. Figure 3 shows the location, as of 1936, of egg-drying equipment in the United States and indicates whether equipment is available for drying all egg products or only specific parts of the egg. As indicated by this map, egg-drying equipment is distributed throughout the Middle West and the Pacific coast areas, but there is a concentration of plants in Texas. There has also been some drying of eggs in at least two other plants in Missouri, but it is understood that these plants were primarily equipped for milk drying.

TABLE 2.—*Total available supplies of dried-egg products—imports for consumption plus domestic production, 1921–37*

Year	Domestic production		Imports for consumption		Total available supply			
	1,000 pounds	Shell-egg equivalents (1,000 dozen)	1,000 pounds	Shell-egg equivalents (1,000 dozen)	1,000 pounds	Shell-egg equivalents (1,000 dozen)	Additional dried products which could have been imported or produced without increasing shell-egg equivalents[1]	
							Yolk (1,000 pounds)	Albumen (1,000 pounds)
1921	----------	----------	8,541	36,201	8,541	36,201	3,281	----------
1922	----------	----------	9,877	46,619	9,877	46,619	5,349	----------
1923	----------	----------	5,874	35,901	5,874	35,901	5,851	----------
1924	----------	----------	8,552	38,399	8,552	38,399	3,988	----------
1925	----------	----------	11,262	43,558	11,262	43,558	2,963	----------
1926	----------	----------	10,494	44,171	10,494	44,171	3,930	----------
1927	556	2,148	7,457	41,019	8,013	41,511	5,543	----------
1928	217	928	7,975	33,926	8,192	33,954	2,896	----------
1929	202	803	10,913	49,729	11,115	49,852	5,163	----------
1930	489	2,042	10,971	43,346	11,460	43,368	2,703	----------
1931	553	2,227	10,238	34,559	10,791	34,801	575	----------
1932	2,285	7,876	2,024	14,586	4,309	19,203	1,961	----------
1933	3,713	17,084	2,518	9,980	6,231	27,069	2,608	----------
1934	4,373	17,020	2,724	9,724	7,097	21,780	----------	15
1935	3,000	11,946	6,431	23,191	9,431	30,347	----------	479
1936	1,360	4,539	7,851	29,125	9,211	32,280	1,330	----------
1937	2,401	7,671	8,871	34,204	11,272	40,688	2,015	----------

[1] See footnote 2 to table 1.

During 1936 there were 11 firms with 15 egg-drying plants either in active operation or which could be placed in operation on short notice. This equipment could produce approximately 12,000 pounds of spray albumen, 15,000 pounds of flake albumen, and either 35,000 pounds of spray yolk or 20,000 pounds of spray whole egg per workday of 8 to 10 hours. Spray yolk and spray whole egg are produced with the same equipment, but of course if yolk is being dried, whole egg cannot be dried at the same time in the same drier. A larger quantity of yolk than of whole egg can be dried in a spray drier dur-

ing a given period. Pan-dried or flake albumen can be pulverized and the product mixed in the proper proportions with spray-dried yolk in order to reconstitute dried whole egg, and some manufacturers prefer to do this rather than produce spray-dried whole egg. Dried whole egg is also produced in flake form, although the practice of most driers is to produce the spray-dried product. Pan-drying is practically a continuous process, and the volume of products produced by this method is calculated on the basis of a 24-hour day, while spray drying is usually limited to an 8-hour day.

The present capacity of egg-drying equipment in the United States is sufficient to dry all the eggs normally consumed in this form in this country. This equipment, even in years favorable for the domestic production of dried-egg products, is used only during the spring months of large supplies of fresh eggs and low prices. In case of an unusual demand for the domestically produced products the operation of these plants could be extended to 24 hours a day with only such time out as would be necessary to clean and repair the equipment. The length of the drying season could also be extended, although extension of the season would normally raise the cost of the dried product to the extent that shell-egg prices might have increased.

The period of the year during which dried eggs could be produced depends only on the length of time during which shell eggs can be purchased in large quantities at low prices. This is usually the latter part of March, April, May, June, and the early part of July. A total of more than 7,400,000 pounds of dried eggs could be produced in a season of 120 days with present equipment. Table 2 shows that the combined domestic production and imported supply amounted to 11,272,000 pounds of dried-egg products in 1937, when total supplies were the second largest on record. The difference between the calculated normal capacity of domestic plants and the 1937 total supply is 3,872,000 pounds. It is believed that this volume could easily be produced by increasing the length of the workday by approximately 50 percent.

METHODS OF PRODUCTION IN THE UNITED STATES

Where shell eggs are used for drying, the common practice is to candle them on receipt at the plant and thus remove eggs which are inedible or undesirable for breaking. The eggs are chilled in order to facilitate separation and then sent to the breaking room, where the workers (generally women) break the eggs by striking them against a blunt knife-edge. If the yolk and albumen are not to be separated, the liquid egg is dropped into a small sterilized cup. After every second or third egg, the contents of the cup are smelled for off odors before being emptied into a pail. If the yolk and albumen are to be separated a small concave disc, just about large enough to hold the yolk of an egg, is attached near the knife, and the broken egg is allowed to drop on this disc. The albumen falls into a cup below the disc, and the yolk is emptied into another cup.

The liquid whole egg and the yolk are churned to secure a smooth, homogeneous mixture before being emptied into tanks or vats. In many plants the albumen is forced through fine screens to break down the fibrous structure, or is subjected to a clarification process which removes all particles of egg shell and mixes the albumen so that the thick and thin portions are evenly distributed.

There are several variations in methods of production of each of the three principal types of dried-egg products. Whole egg may be dried either by the spray, drum, or pan method. In the case of the first method, the finished product will be in powder form, while in the latter two instances the product will be in flake form. Some

FIGURE 4.—Egg-breaking room. Eggs are broken out of the shell, placed in buckets, and conveyed out of the room ready to be frozen or dried.

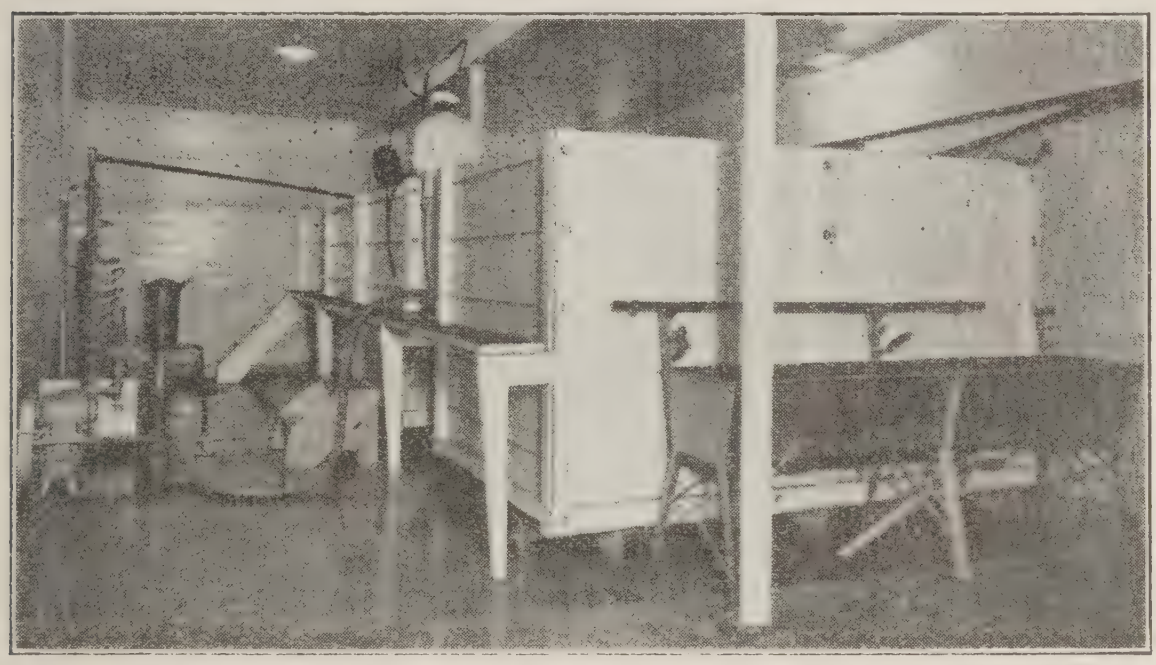

FIGURE 5.—Albumen-processing vats. These vats are filled with liquid albumen to which various chemicals are added to hasten break-down of the thick portion of the albumen. This break-down is accomplished in about 30 minutes, whereas the old process of fermentation required 24 to 36 hours.

manufacturers add sugar to whole-egg powder, and in some instances special brands of whole-egg powder are fortified with additional yolk. In recent years dried yolk has been produced in the United States entirely by the spray method. In the case of this product, too, sugar is sometimes added. Albumen is usually sold in crystal form. This form is produced in most cases by the pan-drying method, although

in many instances the crystals are pulverized and sold as granulated albumen. During the last year or two at least two manufacturers have been producing a powdered albumen by the spray process. In the case of dried albumen, some products which have other ingredients added to egg albumen are sold under particular trade names.

The moisture content of fresh liquid whole egg averages about 75.5 percent, that of yolk 49 percent, and that of albumen 87.5 percent. Spray-dried yolk and whole egg contain up to 3.5 percent moisture, and pan-dried whole egg or albumen from about 7 to as high as 12 percent. The pan-dried products usually require refrigerated storage to prevent deterioration, and in the trade these products are sometimes referred to as semidried to differentiate them from spray-dried products.

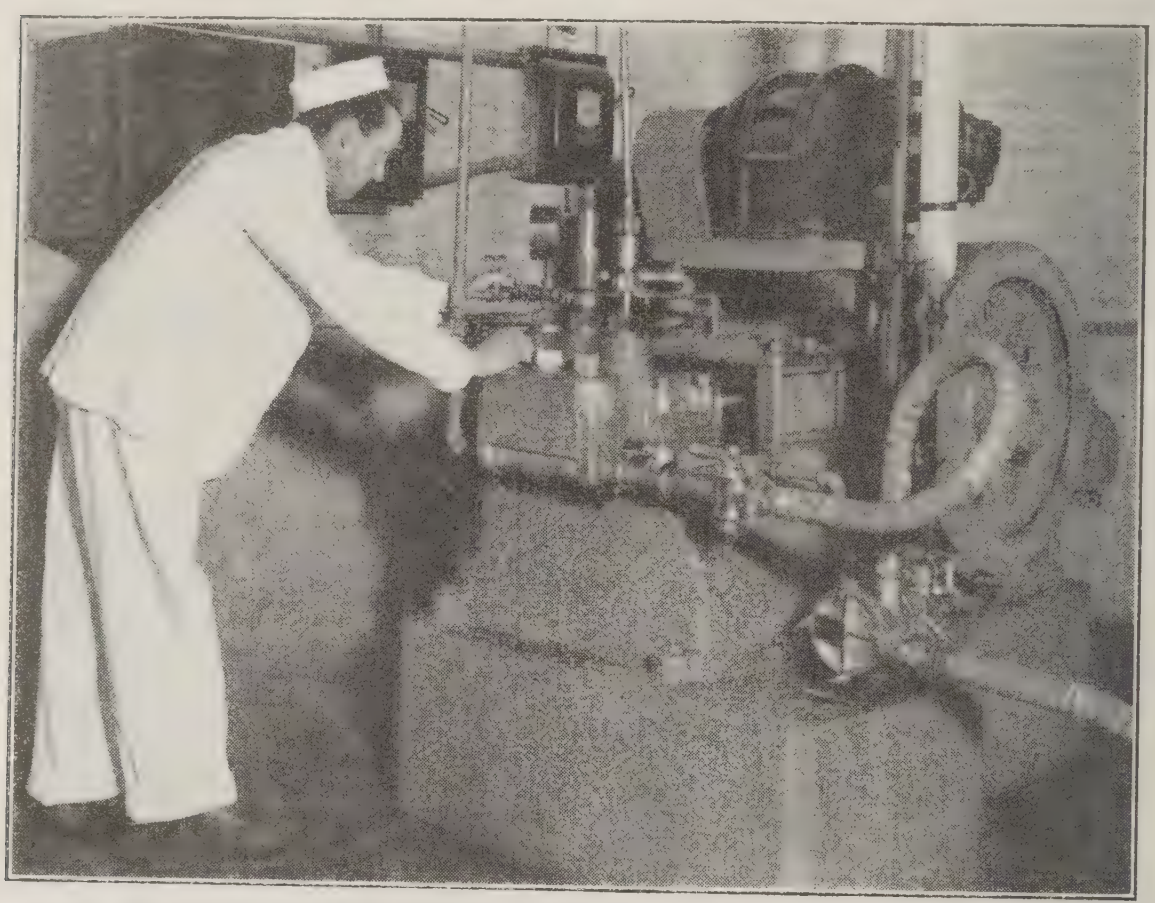

FIGURE 6.—High-pressure pump for forcing liquid egg through atomizing nozzle.

As far as can be learned, only dried whole egg was produced in this country prior to the war. Mr. LaMont's earliest patents described the process as that of drying a batter of beaten eggs, in a thin film, upon revolving plates or discs where the eggs were dried by exposure to heated air. Mr. Stoddard was issued patents in 1875 and 1876 for a rotating drum for drying eggs. The earliest patent obtained for a spray device for drying eggs was issued on January 29, 1901, to R. Stauf of Posen, Germany. Before that time most of the dried eggs were probably produced by methods such as that described by an early writer:[11]

> Eggs are broken and churned, thoroughly mixing whites and yolks. The liquid is dropped on slowly revolving stone cylinders from the arms of the same material extended. Over these cylinders is passed a strong current of

[11] The Egg Reporter, January 20, 1899.

warm, dried air evaporating the moisture from the eggs. When thoroughly dried a stone table fitting closely to the cylinders with channels cut for the arms to pass through is pushed against the cylinder grabbing off the eggs and depositing the crystallizations on the table.

All the processes that have been commercially successful in the manufacture of dried-egg products are based on the principle of removing the water by evaporation in the presence of heat. The meth-

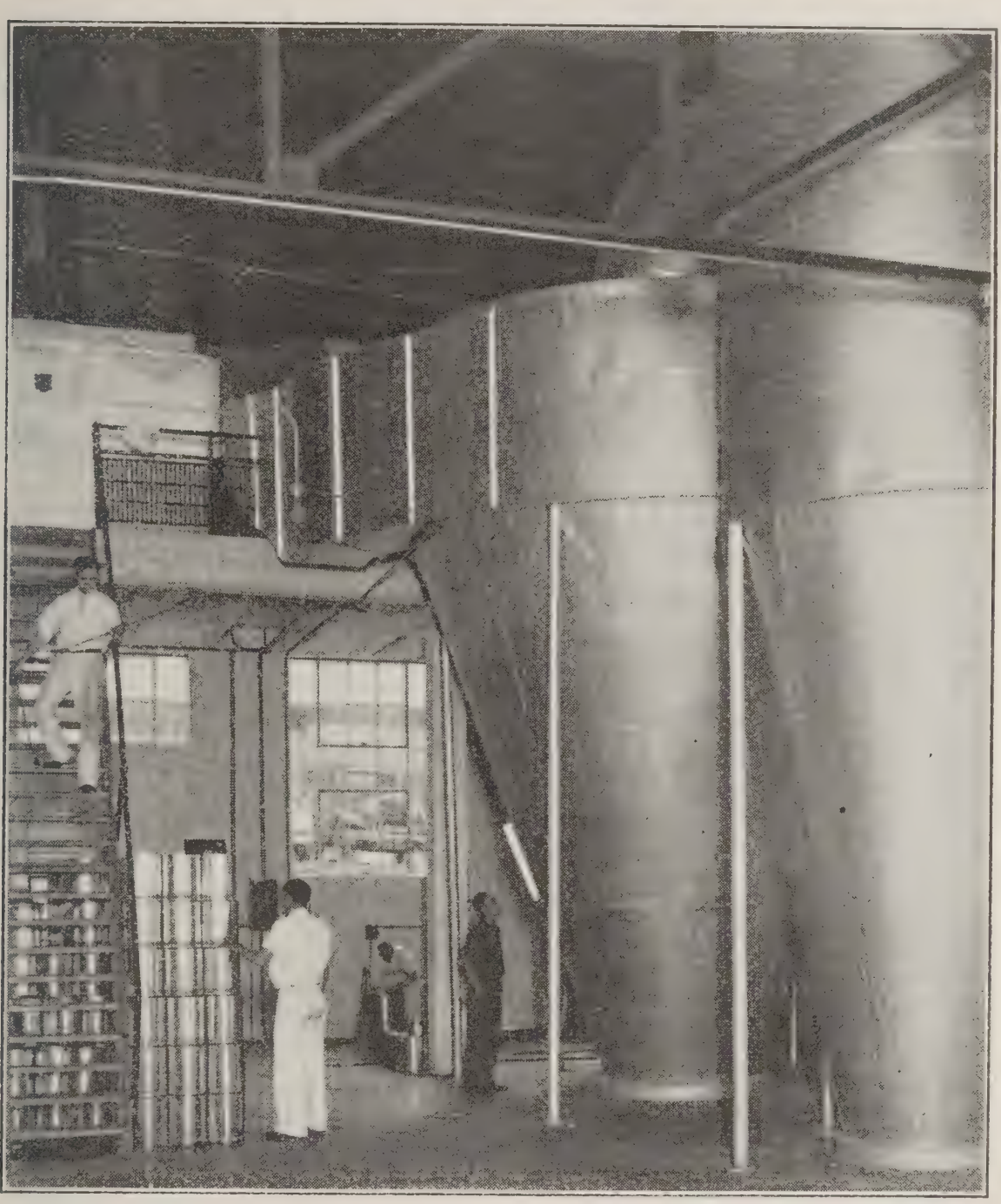

FIGURE 7.—Spray-drying chambers showing how the air outlet from the top of the first drying chamber passes into the second chamber. The man on the stairs is carrying an atomizing nozzle which has been removed from the drying chamber.

ods which have been used can be classified as the spray-drying, pan-drying, drum-drying, belt-drying, and the vacuum-drying systems. A list of patents concerning these methods is contained in appendix C.

The spray-drying method has been used for a number of years to remove moisture from all types of food products, and there are at least two companies which manufacture spray driers although

many of the plants have manufactured their own equipment. The principle of spray drying is that of reducing the liquid-egg product to an exceedingly fine spray or mist in the presence of heated air. The liquid egg is forced by powerful pumps through fine nozzles, under pressure of 1,500 to 3,000 pounds per square inch, into a high-ceilinged, conical chamber kept at a temperature of 160° to 220° F.

FIGURE 8.—Bottom of spray-drying chamber showing a spiral conveyor which cools the dried-egg product and conveys it to a packaging machine.

The air in the drying chamber is brought in through a filter which removes dust and impurities and is circulated rapidly by a blower, thus making a cyclonic current of hot air. This heated air mixing with the atomized liquid egg diffused through the chamber results in an almost instantaneous drying of the liquid product as it is sprayed from the nozzle or nozzles, the dried product falling down the steeply sloping sides of the chamber in the form of a flour-like powder. In many instances the air, which enters at the side of the

top of the drying chamber, escapes through the center of the top into a second chamber or dust collector. Loss of egg dust with the escaping air is thus entirely prevented because the air discharged from the drying chamber passes into the dust collector and any particles of

FIGURE 9.—Sifting and barrelling operation which is carried on after the dried-egg product has been received from the spiral conveyor shown in the upper right of this picture.

dried egg that might be carried over from the drying chamber with the escaping air are collected at the bottom of this auxiliary chamber.

Some types of spray driers are self-cleaning, having a long blade, or series of chain links, which revolves in the cylinder and removes any particles of egg from the side walls. In other cases, it is necessary to stop the drier at the end of each day's operation and

thoroughly clean the machinery to prevent the egg powder from becoming tainted. The dried product as it emerges from the discharge end of the drying chamber is quite hot and may show a tendency to cling together in lumps. A rotary spiral conveyor such as that shown in figure 8 is often used to obtain a cool, uniform product. At the end of the spiral conveyor, the dried product is usually emitted from the conveyor into a shaker, from which it falls into a barrel. In some of the drying plants, the conveyor is not used but the dried product falls from the heating chamber through a sifter into a large, shallow tray, where it is stirred before being placed in barrels.

In recent years the spray method has been used almost exclusively for drying whole egg and yolk. The belt method of drying, in which a metal belt revolves slowly in a heated chamber and several applications of liquid product are placed on the revolving belt, was devised in this country and used here at one time for drying whole egg and yolk. The principle of drying a liquid on a heated revolving metal drum, which is basically the same as the belt method, was developed in the middle of the nineteenth century for desiccating liquid gelatin. While this system was used extensively in the United States prior to the World War, practically no dried-egg products are produced in this country by this method at the present time.

In the spray-drying of albumen a somewhat different process is used. Until very recent years manufacturers had but little success in producing a spray-dried or powdered albumen, largely because the action of spraying tends to coagulate the albumen, thus making the product insoluble in water. It had also been difficult to obtain complete recovery of dried albumen from the standard spray-drying machines since the powder is of much finer texture than spray-dried whole egg or yolk and has a tendency to blow off into the air in the form of dust. One manufacturer has developed equipment to spray-dry albumen by installing at the bottom of the heating chamber a large suction fan to draw the fine particles of dried albumen down from the top of the chamber and force them into an elaborate dust collector instead of blowing them down from the top as is done in the case of yolk and whole egg. Spray-dried albumen, particularly where the fermenting process is accomplished quickly with the aid of chemicals, obviously saves a great deal of time. It is claimed that the whole process, which used to require several days, can now be carried out in 30 minutes.

Whether the spray or pan-drying method is used, the albumen must be subjected to a process of fermentation. Since albumen is composed of two portions known as the thick and the thin portions, and since only the thin portion possesses the proper whipping or beating properties, fermentation is needed in order to reduce the thick portion to the same consistency and texture as the thin portion. The albumen is usually placed in vats and heated slightly in order to encourage fermentation. At the same time it is allowed to settle so that the scum or foam which is produced by the fermentation process will rise to the surface, while the tough membranous portions will form a sediment on the bottom of the vat. Both of these separations, which amount to as much as 5 to 8 percent of the total product, are discarded as being unfit for drying. However, a new process was developed in 1937, by Dr. T. L. Swenson of the Bureau of Chemistry and Soils, United States Department of Agriculture, which

makes it possible to convert this material into dried albumen. This process is accomplished by the addition of citric acid and an acid solution of pepsin, and the resulting dried product is usable for all purposes for which albumen is ordinarily used.

In 1936 the United States Department of Agriculture [12] reported that—

> A process for drying egg whites in one-third to one-fourth the time required by the old fermentation method, yet producing a product which more nearly resembles fresh egg whites, has been discovered by chemists of the Bureau of Chemistry and Soils, United States Department of Agriculture.

By this process the albumen is thinned faster than in the natural fermentation method by the addition of trypsin, an enzyme prepared from pancreatic glands. This method also eliminates the objectionable development of bacterial growth during the thinning process because of the relatively short time required; and when the dried product from this process is reconstituted in liquid form, it is found to whip more easily than albumen prepared by the natural fermentation method. The foam produced by whipping is more tenacious so that it stands up better, and it has a sweeter odor.

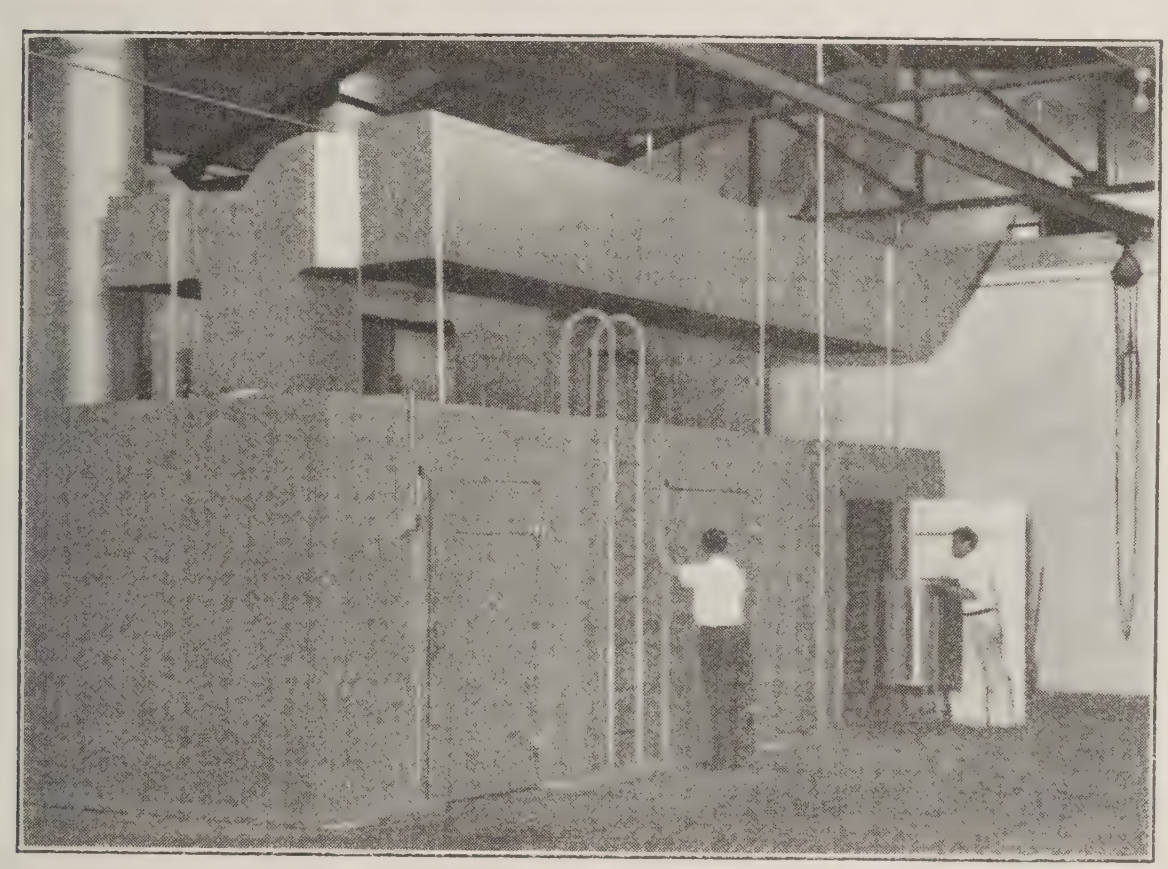

FIGURE 10.—Cabinets for pan-drying albumen, showing the container in which the liquid product is transferred to the cabinets and the shelves, inside one of the doors, on which the pans are placed for drying.

When the pan-drying method is used, the fermented liquid albumen is poured on metal (usually aluminum) pans or trays which have been given a coating of vaseline or neutral mineral oil. These pans of various shapes are placed, usually a thousand or more at a time, on shelves or racks in a heated and ventilated cabinet. The method of heating and the size and capacity of cabinets vary with

[12] Press Service, Office of Information, U. S. Department of Agriculture, Washington, D. C., October 21, 1936. Chemists Use Trypsin to Improve Common Egg Products and Cut Cost.

each company, since this equipment is in nearly every instance made by the drying firm itself. In some cases the racks are on wheels so that they can be wheeled into the drying cabinet. After remaining in this heated cabinet for from 48 to 72 hours the albumen is thoroughly dry but is very soft, and it is usually removed from the pans or trays and placed on tables or on wire mesh to cool before it is broken into flakes and packed.

The containers used for packing dried-egg products have varied considerably from time to time according to the use for which the product is sold. The United States Tariff Commission [13] in 1931 stated that—

> In China the better grades are packed in sealed, tin-lined wooden cases usually of 200 pounds net weight. A part of the output is packed in barrels or casks lined with sized paper. In the United States, where storage facilities are better and where consumers are relatively close at hand, the lined barrels or casks were used in 1927, 1930, and 1931.

Information in regard to current practices in the use of containers indicates that a very small amount of dried egg is packed in tins ranging in weight from 1 to 25 pounds. Another very small quantity of dried yolk and whole egg is packed in 25- or 30-pound cases. The common container in which practically all the output is packed is the wooden barrel, lined with paper. Barrels containing from 120 to 250 pounds are used, with 150 and 200 pounds being the predominant size.

CONVERSION FACTORS USED IN DETERMINING YIELD OF DRIED-EGG PRODUCTS FROM LIQUID AND SHELL EGGS

Since shell eggs vary greatly in size and weight, it is impossible to determine precise conversion factors for the number of pounds of liquid egg in 1 dozen eggs. The actual yield of liquid egg from shell eggs varies with size and quality of eggs used, which are in turn affected by such factors as the breeding of the stock producing the eggs, the season of the year, the feed used, and the care with which the eggs are handled.

The Bureau of Agricultural Economics [14] has reported that one case of shell eggs (30 dozen) will yield an average of 35.3 pounds of liquid egg, but infers that this amount is obtainable with only perfect separation. For this reason the Bureau uses an average of 35 pounds per case or 1.1667 pounds per dozen as the standard. The United States Tariff Commission [15] has also used the same yield per dozen eggs. Althought some firms have reported yields of 36 and 37 pounds per case, it is believed that 35 pounds represents an average yield for the country as a whole.

It is also necessary to know the relative proportion of albumen and yolk contained in liquid egg in order to compute yields of dried-egg products. The Bureau of Agricultural Economics [16] reported that 100 pounds of liquid egg contains 55 pounds of albumen and 45 pounds of yolk, or that the 35 pounds of liquid egg in a case of

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[13] Report to the President on Dried Egg Products. U. S. Tariff Commission, Report No. 25, second series, June 16, 1931, p. 6, footnote 3.
[14] Handbook of Poultry and Egg Statistics. Miscellaneous Publication No. 158, U. S. Department of Agriculture, 1937, revised edition, p. 116.
[15] Report to the President on Dried Egg Products. Report No. 25, second series, June 16, 1931, p. 11.
[16] Handbook of Poultry and Egg Statistics. Miscellaneous Publication No. 158, U. S. Department of Agriculture, 1937, revised edition, p. 116.

eggs will yield 19.25 pounds of albumen and 15.75 pounds of yolk. While the proportion of albumen to yolk will vary according to the quality of the egg, the care with which the albumen is separated from the yolk, etc., these figures which represent average yields will be used throughout this report.

One of the important considerations in connection with the cost of drying eggs is the amount of dried product that can be obtained from a given amount of liquid whole egg, albumen, and yolk. Fairly wide variations were reported by different firms in the percentage yields of dried from liquid products. This variation, which is to some extent seasonal in character, is partially due to the varying proportion of moisture in liquid eggs of different qualities. In drying eggs by the spray method, particularly in the case of albumen, another source of variation is that the resulting product is so fine that it is difficult to prevent some of the product from escaping in the heated air exhaust. Variations occur also because some firms remove a larger proportion of the moisture from the eggs than do others.

The Bureau of Agricultural Economics [17] reports figures obtained from the Tariff Commission showing that 3.6 pounds of liquid whole egg will yield 1 pound of dried whole egg, and on this basis there would be a 27.8 percent yield of the dried product from the liquid whole egg. Not a great deal of dried whole egg is produced in this country at the present time, but reports from two firms which did dry a fairly substantial quantity in 1934 and 1935 indicate that it has been possible for them to make 1 pound of dried whole egg from 3.57 pounds of liquid whole egg. Thus they obtained a yield of 28.01 percent, which is being used in this report.

The Bureau of Agricultural Economics [18] also reports that 2.25 pounds of liquid yolk will yield 1 pound of dried yolk, which is equivalent to a yield of 44.4 percent. It was found, however, that in actual practice egg-drying firms were able to obtain a somewhat greater yield. The four firms which produced the largest quantity of dried yolk in this country reported that they obtained yields which averaged 46.6 percent in 1935, and that these yields were approximately the same in 1934, although slightly lower in two cases. It appears, on the basis of this evidence, that the requirements for 1 pound of dried yolk can be reduced at least to 2.20 pounds of liquid yolk instead of 2.25. This is a 45.45 percent yield.

In regard to the yield of dried albumen, the Bureau of Agricultural Economics [19] reports that 7.3 pounds of liquid albumen is required to make 1 pound of the dried product or that the highest yield which can be expected is 13.7 percent. Four firms which dried albumen in 1934 and 1935 obtained average yields in each year of 13.34 percent of the liquid product. However, the two firms which reported the largest volume of this product obtained yields approximating or slightly above 13.7 percent. That figure will therefore be used in this report.

Table 3 shows the conversion factors, as described above, that have been used throughout this study, particularly in arriving at estimated cost figures.

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[17] Handbook of Poultry and Egg Statistics. Miscellaneous Publication No. 158, U. S. Department of Agriculture, 1937, revised edition p. 116.
[18] *Ibid.*
[19] *Ibid.*

Table 3.—Conversion factors for liquid and dried eggs [1]

Products	Yield of liquid eggs in 1 case (30 dozen) of shell eggs	Yield of 1 dozen shell eggs		Requirements for 1 pound of dried-egg products		Yield of dried product from—	
		Liquid eggs	Dried eggs	Liquid eggs	Shell eggs	100 pounds of liquid eggs	30 dozen shell eggs
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Dozens*	*Pounds*	*Pounds*
Whole egg	35.00	1.1667	0.3268	3.57	3.06	28.01	9.804
Albumen	19.25	.6417	.0879	7.30	11.38	13.70	2.637
Yolk	15.75	.5250	.2386	2.20	4.19	45.45	7.158

[1] Shell eggs consist of 45 percent yolk and 55 percent albumen. 1 pound of dried whole egg contains 0.731 pound of dried yolk and 0.269 pound of dried albumen.

INTERNATIONAL TRADE IN DRIED-EGG PRODUCTS

EXPORTS FROM CHINA AND THEIR RELATIVE IMPORTANCE IN HER FOREIGN TRADE

China is by far the world's major producer of dried-egg products. Except for the United States, no other nation appears to have made a definite effort to establish an egg-drying industry. Turkey and Yugoslavia have been reputed to produce dried-egg products, but a careful search of the available literature and import statistics of the principal importing countries fails to substantiate this. In 1932 an experimental egg-drying factory was opened in Chile and one in Tasmania, Australia,[20] but nothing more has been reported of either of these plants.

An analysis of the international trade in dried eggs, therefore, involves a study of only the Chinese volume of exports. The volume and destination of the exports from China of dried yolk, dried albumen, and dried whole egg are given in tables 4, 5, and 6, respectively. Table 7 recapitulates the total exports of these products to show the total exports of all dried-egg products.

TABLE 4.—*Exports from China of dried yolk*

[In thousands of pounds, i. e., 000 omitted]

Year	United States	Great Britain	Germany	Belgium	Denmark	France	Netherlands	Italy	Japan	Canada	Others	Total
1925	6,038	688	2,293	401	216	686	599	3	39	233	32	11,228
1926	3,376	652	2,332	606	73	655	755	11	75	18	34	8,587
1927	3,066	1,409	1,914	179	30	800	968	6	138	47	42	8,599
1928	3,955	887	1,916	305	41	665	1,090	15	461	39	55	9,429
1929	6,022	991	1,740	488	61	650	1,480	13	582	71	113	12,211
1930	4,425	300	1,337	295	49	447	654	16	1,636	96	68	9,323
1931	3,026	381	1,603	502	55	842	1,054	14	26	------	16	7,519
1932	1,498	349	1,394	755	64	620	539	12	------	------	55	5,286
1933	2,030	460	1,692	1,396	101	709	1,039	28	------	------	44	7,499
1934	2,306	368	2,332	1,212	45	414	1,048	102	------	------	53	7,880
1935	5,147	782	2,404	472	------	563	991	58	46	------	76	10,539
1936	5,290	703	3,364	880	------	574	899	4	------	------	52	11,766

Chinese Maritime Customs returns

[20] World Dairy and Poultry News. Department of Commerce, 1932.

TABLE 5.—*Exports from China of dried albumen*

[In thousands of pounds, i. e., 000 omitted]

Year	United States	Great Britain	Germany	Belgium	Denmark	France	Netherlands	Italy	Japan	Canada	Spain	Others	Total
1925	4,087	2,523	926	132	71	364	340	67	87	42	17	40	8,696
1926	3,469	2,327	887	151	13	245	322	113	176	11	50	38	7,802
1927	2,479	1,395	1,017	226	23	414	417	39	281	16	47	49	6,403
1928	2,327	2,230	1,267	202	56	349	546	75	344	36	63	22	7,517
1929	3,498	1,685	1,317	351	98	341	437	58	556	31	46	35	8,453
1930	2,267	1,602	1,174	194	138	371	637	98	956	12	81	55	7,585
1931	1,725	2,121	775	261	124	491	551	60	119	24	47	36	6,334
1932	1,675	1,783	665	338	118	539	379	54	97	12	64	28	5,752
1933	414	2,018	728	357	105	567	625	93	117	9	69	56	5,158
1934	777	2,073	934	405	18	372	604	138	147	26	71	97	5,662
1935	2,596	1,989	1,067	413	31	367	554	80	163	------	73	90	7,423
1936	2,387	2,339	1,761	439	9	450	566	40	208	------	30	168	8,397

Chinese Maritime Customs returns.

TABLE 6.—*Exports from China of dried whole egg*

[In thousands of pounds, i. e., 000 omitted]

Year	United States	Great Britain	Germany	Belgium	Denmark	France	Netherlands	Italy	Japan	Canada	Others	Total
1925	2,463	7,989	323	78	-------	290	62	11	-------	80	------	11,296
1926	788	1,928	24	27	-------	24	83	6	-------	33	------	2,913
1927	270	1,039	80	------	-------	29	232	------	29	------	------	1,679
1928	1,491	980	104	13	-------	51	233	4	37	5	------	2,918
1929	1,057	1,419	67	79	-------	25	129	1	-------	------	1	2,778
1930	781	1,148	69	------	-------	238	37	7	11	22	2	2,315
1931	588	497	59	------	-------	14	137	------	75	------	------	1,370
1932	9	1,252	61	22	-------	8	23	------	-------	------	------	1,375
1933	8	712	131	------	6	19	11	------	-------	------	------	887
1934	17	289	171	35	-------	38	94	7	-------	------	------	651
1935	559	697	159	3	-------	11	61	------	-------	------	2	1,492
1936	-------	778	691	29	-------	72	198	------	-------	------	385	2,153

Chinese Maritime Customs returns.

TABLE 7.—*Total exports from China of all dried-egg products, by country of destination*

[In thousands of pounds, i. e., 000 omitted]

Year	United States	Great Britain	Germany	Belgium	Denmark	France	Netherlands	Italy	Japan	Canada	Spain	Others	Total
1920	15,590	28,859	1,453	1,057	157	2,157	1,522	661	552	804	------	3,615	56,427
1921	8,755	38,562	2,932	585	22	590	394	79	205	45	18	189	52,376
1922	8,910	37,065	4,738	1,520	205	2,918	1,225	364	461	82	65	89	57,642
1923	12,623	26,200	2,561	1,124	416	4,770	1,141	417	166	104	64	752	50,338
1924	11,580	29,505	7,217	1,955	396	6,017	2,879	898	196	150	22	246	61,061
1925	12,588	11,200	3,542	611	287	1,340	1,001	81	126	355	17	72	31,220
1926	7,633	4,907	3,243	784	86	924	1,160	130	251	62	50	72	19,302
1927	5,815	3,843	3,011	405	53	1,243	1,617	45	448	63	47	91	16,681
1928	7,773	4,097	3,287	520	97	1,065	1,869	94	842	80	63	77	19,864
1929	10,577	4,095	3,124	918	159	1,016	2,046	72	1,138	102	46	149	23,442
1930	7,473	3,050	2,580	489	187	1,056	1,328	121	2,603	130	81	125	19,223
1931	5,339	2,999	2,437	763	179	1,347	1,742	74	220	24	47	52	15,223
1932	3,182	3,384	2,120	1,115	182	1,167	941	66	97	12	64	83	12,413
1933	2,452	3,190	2,551	1,753	212	1,295	1,675	121	117	9	69	100	13,544
1934	3,100	2,730	3,437	1,652	63	824	1,746	247	147	26	71	150	14,193
1935	8,302	3,468	3,630	888	31	941	1,606	138	209	------	73	168	19,454
1936	7,677	3,820	5,816	1,348	9	1,096	1,663	44	208	------	30	605	22,316

Chinese Maritime Customs returns

It should be noted in table 7 that during the years 1920 through 1924 the exports of all dried eggs were on a markedly higher level than in later years. This situation was probably brought about by

the war conditions in Europe, as it was not until 1925 that European agriculture, including the poultry industry, returned to approximately its pre-war level of production. An examination of table 7 shows that since 1924 there has been practically no trend in the total volume of all dried-egg products exported from China except for the depression years of 1931 through 1934 when exports were at a low level. There has been a shift from the use of dried whole egg to yolk and albumen which is shown by the figures on Chinese exports in table 8. These figures show that in 1925, yolk represented 36 percent of the total exports while in 1936 they represented 53 percent.

TABLE 8.—*Total exports from China of all dried-egg products, by type of product*

Year	Dried yolk	Percent of total	Dried albumen	Percent of total	Dried whole egg	Percent of total	Total exports [1]
	1,000 pounds		*1,000 pounds*		*1,000 pounds*		*1,000 pounds*
1920							56,427
1921							52,376
1922							57,642
1923							50,338
1924							61,061
1925	11,228	36.0	8,696	27.9	11,296	36.2	31,220
1926	8,587	44.5	7,802	40.4	2,913	15.1	19,302
1927	8,599	51.6	6,403	38.4	1,679	10.1	16,681
1928	9,429	47.5	7,517	37.8	2,918	14.7	19,864
1929	12,211	52.1	8,453	36.1	2,778	11.8	23,442
1930	9,323	48.5	7,585	39.5	2,315	12.0	19,223
1931	7,519	49.4	6,334	41.6	1,370	9.0	15,223
1932	5,286	42.6	5,752	46.3	1,375	11.1	12,413
1933	7,499	55.4	5,158	38.1	887	6.5	13,544
1934	7,880	55.5	5,662	39.9	651	4.6	14,193
1935	10,539	54.2	7,423	38.2	1,492	7.7	19,454
1936	11,766	52.7	8,397	37.6	2,153	9.6	22,316

[1] Prior to 1925 the exports of all dried-egg products were listed as "dried eggs."
Chinese Maritime Customs returns.

Not only is China the world's major producer of dried eggs, but the value of her egg exports bulks quite large in comparison to the value of her total export trade. During the years 1932 through 1935 the exports of all dried- and frozen-egg products, and shell and preserved eggs ranked third in value of all her exports, exclusive of silver. Table 9 shows the value, in haikwan taels, of the total exports of all commodities, the value of the exports of all egg products, and the value of exported dried-egg products. These values have been converted to United States currency at the average annual exchange rate. This table also shows in percentages the value of all egg products, as well as the value of dried-egg products in relation to the value of all exports. During the past 8 years these percentages have averaged approximately 5.2 and 1.5 percent, respectively. The sharp decline during the last few years in the value of China's egg exports does not, of course, reflect a comparable decline in the exported volume of these products. This is evidenced by table 8, which shows that the volume of dried eggs exported in 1936 was practically as large as in 1929, and larger than in any other year since 1925.

Table 4 through 7 show the United States to be China's best customer for dried yolk and albumen, and China's second best customer for dried whole egg. For all dried-egg products combined, the United States has ranked first in practically all years. Table 10 illustrates

the importance of the United States as a user of Chinese eggs by showing the percent that the United States' imports for consumption are of the total Chinese exports. In computing these percentages the official statistics of the United States imports for consumption were used instead of the Chinese exports to the United States because of the discrepancies existing between the two sources of data.

TABLE 9.—*Value of China's total exports of all commodities and the value of her exports of all eggs and dried-egg products*

Year	Total exports	Exports of all egg products	Exports of dried-egg products	Total exports	Exports of all egg products	Exports of dried-egg products	Percent exports of all egg products is of total exports	Percent exports of dried eggs is of total exports
	1,000 haikwan taels	*1,000 haikwan taels*	*1,000 haikwan taels*	*1;000 U. S. dollars*	*1,000 U. S. dollars*	*1,000 U. S. dollars*		
1921	601, 256	24, 697	----------	456, 955	18, 770	----------	4.1	----------
1922	654, 892	28, 955	----------	543, 560	24, 033	----------	4.4	----------
1923	752, 917	29, 622	----------	602, 334	23, 698	----------	3.9	----------
1924	771, 784	31, 523	11, 156	625, 145	25, 534	9, 036	4.1	1.4
1925	776, 353	33, 013	12, 313	652, 137	27, 731	10, 343	4.3	1.6
1926	864, 295	38, 174	11, 743	656, 864	29, 012	8, 925	4.4	1.4
1927	918, 620	33, 526	9, 660	633, 848	23, 133	6, 665	3.6	1.1
1928	991, 355	43, 779	12, 696	703, 862	31, 083	9, 014	4.4	1.3
1929	1, 015, 687	51, 720	13, 679	650, 040	33, 101	8, 755	5.1	1.3
1930	894, 844	51, 161	10, 970	411, 628	23, 534	5, 046	5.7	1.2
1931	909, 476	37, 758	9, 035	327, 411	13, 593	3, 253	4.2	1.0
1932	492, 641	28, 409	7, 773	167, 498	9, 659	2, 643	5.8	1.6
	1,000 standard dollars	*1,000 standard dollars*	*1,000 standard dollars*					
1933	611, 828	23, 414	6, 990	161, 461	8, 642	2, 580	5.4	1.6
1934	535, 214	19, 412	6, 201	182, 454	9, 256	2, 957	5.1	1.6
1935	575, 809	20, 584	7, 651	210, 573	10, 529	3, 913	5.0	1.9
1936	705, 741	26, 831	10, 304	209, 676	11, 148	4, 281	5.3	2.0

Chinese Maritime Customs returns

TABLE 10.—*Percentage that United States imports for consumption is of total Chinese exports of all dried-egg products* [1]

Year	Dried yolk	Dried albumen	Dried whole	Total	Year	Dried yolk	Dried albumen	Dried whole	Total
1924	----------	----------	----------	14.0	1931	75.7	39.2	151.0	67.2
1925	49.8	36.2	22.3	36.1	1932	13.7	22.2	1.6	16.3
1926	63.6	44.3	54.1	54.4	1933	21.8	16.9	1.1	18.6
1927	37.3	52.6	52.4	44.7	1934	29.4	7.1	.2	19.2
1928	46.4	36.6	29.2	40.2	1935	37.5	25.3	40.4	33.1
1929	44.8	47.0	53.1	46.6	1936	41.7	28.8	24.8	35.2
1930	66.4	45.5	57.4	57.1					

[1] An illustration of the discrepancy between the official Chinese exports statistics and statistics on United States imports for consumption is shown in the figures for 1931 when the Unites States imports of dried whole egg amounted to 151 percent of the Chinese exports to all countries. This condition occurred as the result of heavy withdrawal from bonded warehouses in the United States of large quantities of dried whole egg immediately prior to the tariff increase of 50 percent in July 1931.

With the United States as the principal market for Chinese dried eggs, table 7 shows that, during the past 4 years, the next most important countries have been Germany, Great Britain, Netherlands, and Belgium. Although Germany has imported more dried-egg products during recent years than Great Britain it is not believed that Germany actually consumes more. Germany reexports to neighboring central European countries a considerable quantity of dried eggs as a consequence of her established wholesaling and jobbing trade.

UNITED STATES IMPORTS OF DRIED-EGG PRODUCTS AND THEIR RELATIVE IMPORTANCE IN OUR FOREIGN TRADE

The United States imports for consumption of all dried-egg products, with the shell-egg equivalents for the total imports, are shown in table 11. Since dried yolk and albumen are never imported in the same proportion as they are found in shell eggs the figures, given in the fifth column of table 11 which shows the shell-egg equivalents of the total imports in dozens, are always somewhat greater than the actual number of shell eggs required to yield the amount of dried products that are imported. In all years except 1934 there was a proportionately greater amount of albumen imported than yolk. In calculating the total shell-egg equivalents no allowance can be made for the disproportionate imports. The sixth and seventh columns, therefore, show the additional quantities of dried products that could have been imported without increasing the shell-egg equivalents of the total imports. The shell-egg equivalents of our imports for consumption should therefore be read, for the year 1936, as 29,125,000 dozens less 1,660,000 pounds of dried yolk.[21]

TABLE 11.—*United States imports for consumption of dried-egg products*

[All figures in thousands, i. e., 000 omitted]

Year	Dried yolk	Dried albumen	Dried whole egg	Total imported	Shell-egg equivalents [1]	Additional dried product which could have been imported without increasing the shell-egg equivalents [2]	
						Yolk	Albumen
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Dozens*	*Pounds*	*Pounds*
1920	[3] 2,915	2,720	2,719	8,354	39,270	4,471	----------
1921	[3] 3,897	2,643	2,001	8,541	36,201	3,281	----------
1922	[3] 3,584	3,289	3,004	9,877	46,619	5,349	----------
1923	1,553	2,726	1,595	5,874	35,901	5,851	----------
1924	4,016	2,947	1,590	8,552	38,399	3,988	----------
1925	5,591	3,150	2,521	11,262	43,558	2,963	----------
1926	5,461	3,458	1,575	10,494	44,171	3,930	----------
1927	3,209	3,368	880	7,457	41,019	5,938	----------
1928	4,371	2,752	852	7,975	33,926	3,103	----------
1929	5,465	3,973	1,474	10,913	49,729	5,327	----------
1930	6,191	3,452	1,328	10,971	43,346	3,184	----------
1931	5,689	2,481	2,069	10,238	34,559	1,048	----------
1932	726	1,276	22	2,024	14,586	2,739	----------
1933	1,634	874	10	2,518	9,980	740	----------
1934	2,320	403	1	2,724	9,724	----------	452
1935	3,953	1,876	602	6,431	23,191	1,143	----------
1936	4,902	2,416	533	7,851	29,125	1,660	----------
1937	5,426	2,844	601	8,871	34,204	2,298	----------

[1] Obtained by adding the largest of either the yolk or albumen shell-egg equivalents to the whole shell-egg equivalents.

[2] The shell-egg equivalents of the imported dried yolk and of albumen are never the same. These differences are shown in the last column in terms of the dried products which could have been imported without increasing the number of shell eggs used. For example, the imports for consumption in 1936, in terms of shell eggs, should be read as 29,125,000 dozens less 1,660,000 pounds of dried yolk.

[3] Estimated—based on cross-diagram chart of "yolks, frozen, etc." as percent of total yolk, 1923–32.

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[21] A method of computation other than the one used above is possible, i. e. computing the liquid equivalent of each of the three products, adding them together, and dividing by 1.1667 pounds, the weight of the liquid contents in 1 dozen shell eggs. This method gives a result less accurate than the amounts shown in table 11 but has the advantage of being expressed in only one figure. Data using this second method have been compiled in table III in appendix A.

Table 11 illustrates the declining importance of the imports for consumption of dried whole egg. Imports of this product reached a

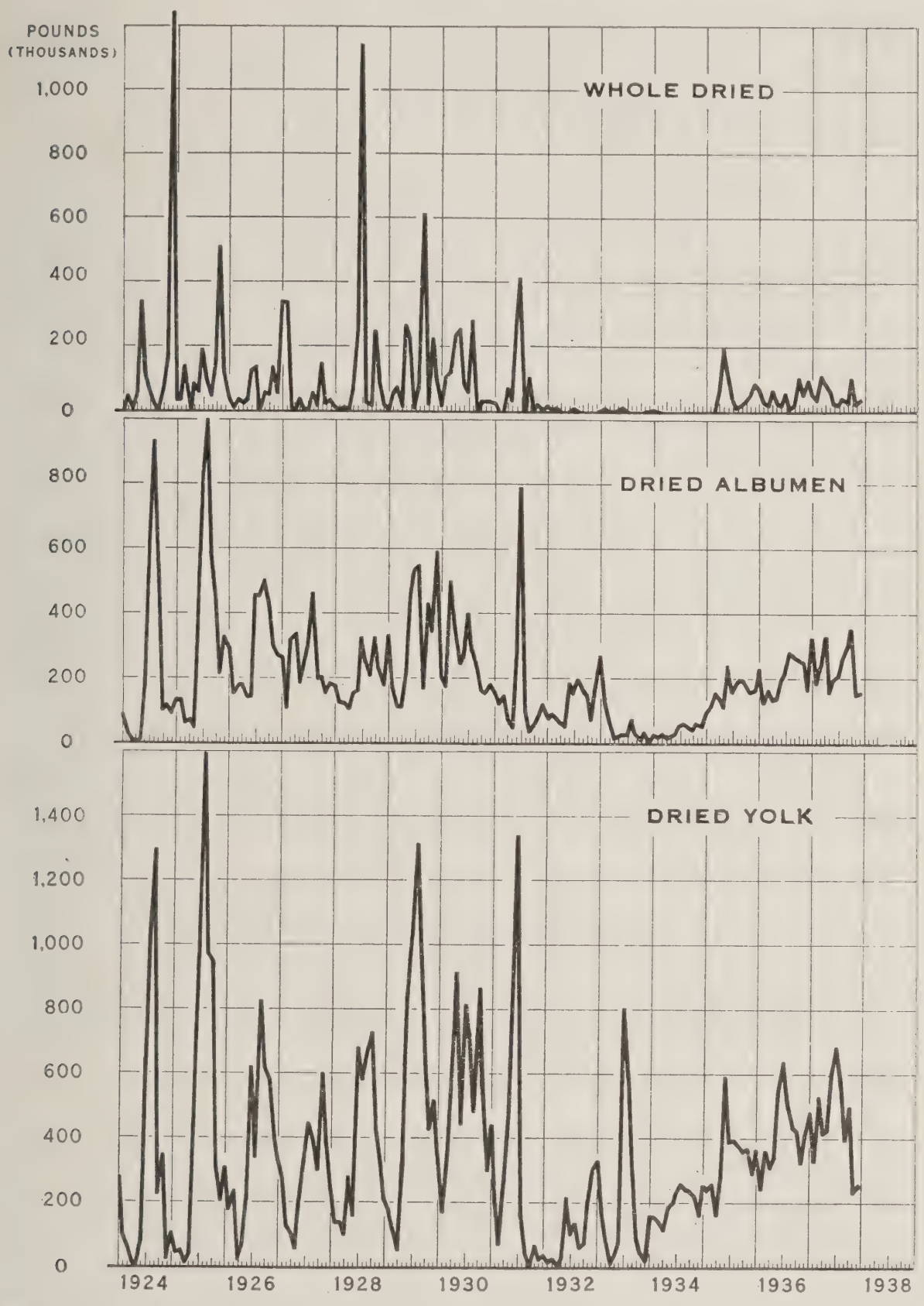

FIGURE 11.—Monthly imports of dried-egg products, 1924–37. With the increase in the tariff in 1931 occurring at the same time that egg prices were declining, the volume of imports fell markedly, and did not return to former levels until 1937. See table IV in appendix A.

peak in 1922 and have since then declined steadily, thus reflecting a change in the use of dried whole egg. Formerly dried whole egg

was used in many food products, but in recent years there has been a decided tendency for manufacturers to substitute dried yolk. If albumen is required in the product being manufactured it may be added as a separate item and not necessarily in the same proportion as in shell eggs, a method which is obvoiusly a convenience. The imports of dried albumen appear to be relatively stable from year to year and no definite trend either upward or downward is apparent, except for the depression period when imports were at a low level. As for dried yolk, it appears that there may have been an upward trend in the imports for consumption which was interrupted by the marked decline that occurred in 1932. If, however, it is remembered that the domestic production of dried yolk during the years 1932 through 1935 averaged approximately 2,400,000 pounds annually, it can be seen that the actual consumption of dried yolk did not decline as much as the imports would indicate.

Figure 11 shows the monthly imports into the United States of the three dried products. It should be noted that the chart shows general imports through 1933 and imports for consumption thereafter.

The value of our imports of all eggs and egg products is quite small, of course, when compared to the total value of all our imports. Table 12, however, shows that when our trade with China only is considered, eggs and egg products imported from that country represent a fairly important proportion of our imports. This table gives the dollar volume of our total imports from China, the dollar volume of our exports to China (for comparative purposes), the value of our imports of all eggs and egg products, and finally the value of our imports of Chinese dried-egg products only. The percent that the values given in the two columns of egg products are of the total imports from China is also shown. This table shows that since 1931 the imports of egg products from China have been practically limited to dried-egg products. There are three principal factors that have caused the almost complete cessation of frozen-albumen and whole-egg imports and have reduced the volume of frozen yolk imported to only a fraction of the former level. These factors are the tariff increase in 1930 on frozen-egg products from 7.5 to 11 cents per pound, the low levels to which shell-egg prices fell during the depression years, and the fact that the domestic egg-freezing industry had been expanding and becoming more and more firmly established.

FACTORS AFFECTING UNITED STATES IMPORTS OF DRIED EGGS

The volume of imports of dried-egg products into the United States depends primarily on two factors in addition to tariffs and other restrictions on imports: (1) The difference in production costs between the United States and China and (2) the extent to which shell eggs and frozen-egg products are interchangeable with dried eggs. This question of the interchangeability of the various egg products will be discussed in a later section, since it is a factor influencing the total consumption of dried eggs and not imports alone.

The basis for China's position as the world's largest producer of dried eggs is principally the low cost of the raw material, and secondly, the low cost of manufacturing charges such as labor, in-

TABLE 12.—*Total value of United States trade with China compared to value of egg products imported from China*

GENERAL IMPORTS

Year	Total United States imports from China	Total United States exports to China	Total imported egg products [1]	Percent total eggs are of United States imports	Imported dried egg products [2]	Percent dried eggs are of total United States imports
	1,000 dollars	*1,000 dollars*	*Dollars*	*Percent*	*Dollars*	*Percent*
1920	192,708	145,737	6,321,526	3.3		
1921	101,136	108,290	2,546,042	2.5		
1922	134,609	100,357	5,154,709	3.8		
1923	187,602	108,595	6,150,238	3.3		
1924	117,888	109,189	5,203,924	4.4	3,761,257	3.2
1925	168,939	94,442	8,167,176	4.8	5,036,046	3.0
1926	143,204	110,205	5,726,166	4.0	4,038,790	2.8
1927	151,680	83,471	4,899,992	3.2	3,672,263	2.4
1928	139,951	137,661	6,182,806	4.4	4,022,985	2.9
1929	166,233	124,163	7,260,461	4.4	5,680,670	3.4
1930	101,464	89,605	4,432,660	4.4	3,779,981	3.7
1931	66,759	97,923	1,693,631	2.5	1,613,536	2.4
1932	26,177	56,171	759,121	2.9	720,033	2.8
1933	37,807	51,942	501,718	1.3	468,616	1.2
IMPORTS FOR CONSUMPTION						
1934	43,933	68,667	403,193	0.9	367,092	0.8
1935	64,200	38,153	1,585,822	2.5	1,477,192	2.3
1936	73,754	46,819	1,961,236	2.7	1,872,336	2.5

[1] Includes value of imports of shell-egg and all frozen- and dried-egg products.
[2] Prior to 1924, dried and frozen eggs were listed in the same classification.

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land transportation, etc. It is estimated that the cost of shell eggs in China during the egg-drying season of March, April, May, and June has represented approximately 86 percent of the selling price of dried whole egg [22] on the Shanghai wholesale market for the entire period from 1925 through 1936. The shell-egg prices, however, were based on the Shanghai wholesale price of "fresh eggs, No. 1," which are somewhat higher in price than the quality and size of eggs used by the drying plants. If it were possible to obtain country or farm prices for shell eggs it is believed that the percentage given above would undoubtedly be smaller, though it is impossible to say how much. The cost of shell eggs in the United States during the 5-year period, 1932–36, has averaged 77.1 percent of the total estimated cost of producing a pound of dried whole egg.

Since shell-egg costs represent such a large proportion of the total costs of producing dried eggs, it can be seen that low egg prices in China are directly responsible for that country's leading position in the industry. That egg prices are low in China is illustrated in table 13, which shows the average monthly difference in price, during each month in the egg-drying season, between the Shanghai wholesale price of "fresh eggs, No. 1," and the average monthly farm price in the four States of Texas, Oklahoma, Kansas, and Missouri, where a majority of the domestic egg-drying plants are located. It is of interest to note that the domestic industry began operating

[22] A price series for dried whole egg on the Shanghai wholesale market is not available. It is possible, however, to compute the probable selling price by "reconstituting," i. e., 1 pound of dried whole egg contains 0.731 pound of dried yolk and 0.269 pound of dried albumen.

in 1927 when in addition to war conditions in China disrupting its industry, the farm price of eggs in this country was only 4.3 cents above the Shanghai level. This low spread was due more to low prices in this country than to high prices in China.

TABLE 13.- *Shell-egg prices: Wholesale price in Shanghai, China; the farm price in the United States; and the amount United States prices are higher than Shanghai prices*

[Prices in cents per dozen]

Year	Shanghai wholesale price [1]					Farm price in 4 States [2]					Difference or spread				
	Mar.	Apr.	May	June	Av.	Mar.	Apr.	May	June	Av.	Mar.	Apr.	May	June	Av.
1923	15.0	12.1	12.1	11.7	12.7	19.5	19.0	18.8	18.2	18.9	4.5	6.9	6.7	6.5	6.2
1924	13.8	11.2	11.5	11.4	12.0	16.5	16.5	17.2	17.8	17.0	2.7	5.3	5.7	6.4	5.0
1925	15.4	14.6	11.4	10.7	13.0	21.8	22.0	22.0	22.5	22.1	6.4	7.4	10.6	11.8	9.1
1926	13.7	10.2	11.7	11.5	11.8	20.2	22.2	22.8	22.5	21.9	6.5	12.0	11.1	11.0	10.1
1927	11.8	12.2	12.0	12.8	12.2	17.8	17.8	16.8	13.5	16.5	6.0	5.6	4.8	.7	4.3
1928	13.0	13.2	13.5	13.0	13.2	21.0	20.5	22.0	20.8	21.1	8.0	7.3	8.5	7.8	7.9
1929	13.8	12.6	11.7	10.8	12.2	22.2	20.5	21.2	22.5	21.6	8.4	7.9	9.5	11.7	9.4
1930	10.8	10.3	9.7	7.7	9.6	18.8	19.2	16.5	15.2	17.4	8.0	8.9	6.8	7.5	7.8
1931	7.7	7.1	6.6	6.7	7.0	15.2	13.6	10.3	11.2	12.6	7.5	6.5	3.7	4.5	5.6
1932	7.6	6.6	6.3	6.3	6.7	7.2	7.5	7.9	7.3	7.5	−.4	.9	1.6	1.0	.8
1933	5.8	5.8	5.9	6.3	6.0	7.1	8.0	9.8	7.3	8.0	1.3	2.2	3.9	1.0	2.0
1934	8.0	6.5	4.1	4.4	5.8	12.1	11.6	11.4	10.6	11.4	4.1	5.1	7.3	6.2	5.6
1935	5.7	5.6	6.2	6.3	6.0	16.9	19.2	19.9	18.9	18.7	11.2	13.6	13.7	12.6	12.7
1936	6.8	6.1	5.9	5.9	6.2	14.2	14.9	16.5	16.3	15.5	7.4	8.8	10.6	10.4	9.3
1937	7.3	7.7	7.5	7.6	7.5	18.2	18.6	15.7	15.1	16.9	10.9	10.9	8.6	7.5	9.4

[1] An Analysis of Shanghai Commodity Prices, 1923-32, and Shanghai Market Prices Report. For prices since 1932, see Prices and Price Indexes in Shanghai. All publications issued by the National Tariff Commission, Shanghai, China. Chinese quotations were converted to United States currency with the monthly average exchange rate furnished by Federal Reserve Board.

[2] Average monthly prices for the 4 States of Texas, Oklahoma, Kansas, and Missouri, from Bureau of Agricultural Economics.

To illustrate further the importance of the spread in egg prices between this country and China as the prime factor affecting our volume of imports, figure 12 is presented showing the relationship between the spread in egg prices and the volume of our imports for consumption. This figure shows that there is generally a positive relationship between the changes from year to year in the total volume of our imports of dried yolk, albumen, and whole egg, and the changes from year to year in the spread between the Chinese and United States shell-egg prices.

Tables 14 and 15 give the average monthly price for dried yolk of first quality, and for dried crystal albumen, without zinc, on the Shanghai wholesale market from 1925 through June 1937. Of the several grades of these products for which prices are quoted on the Shanghai market, the prices in the above-mentioned tables are for the best qualities. Tables 16 and 17 give the average monthly prices in New York City for imported yolk and albumen from 1921 through 1937. These prices include the United States tariff and, since no grade or quality is given, are probably an average price for all qualities sold in New York City. A comparison of the prices as shown in Shanghai and in New York City shows quite a wide spread that cannot be accounted for by ocean freight rates, tariff duties, and all the other charges that are normally encountered. One reason for this is that the Shanghai prices are for large quantities for export, while the New York City prices are probably for small quantities such as 100 pounds or less. The two series of prices are quite comparable, however, in that the changes from month to month and year to year are similar in extent and time.

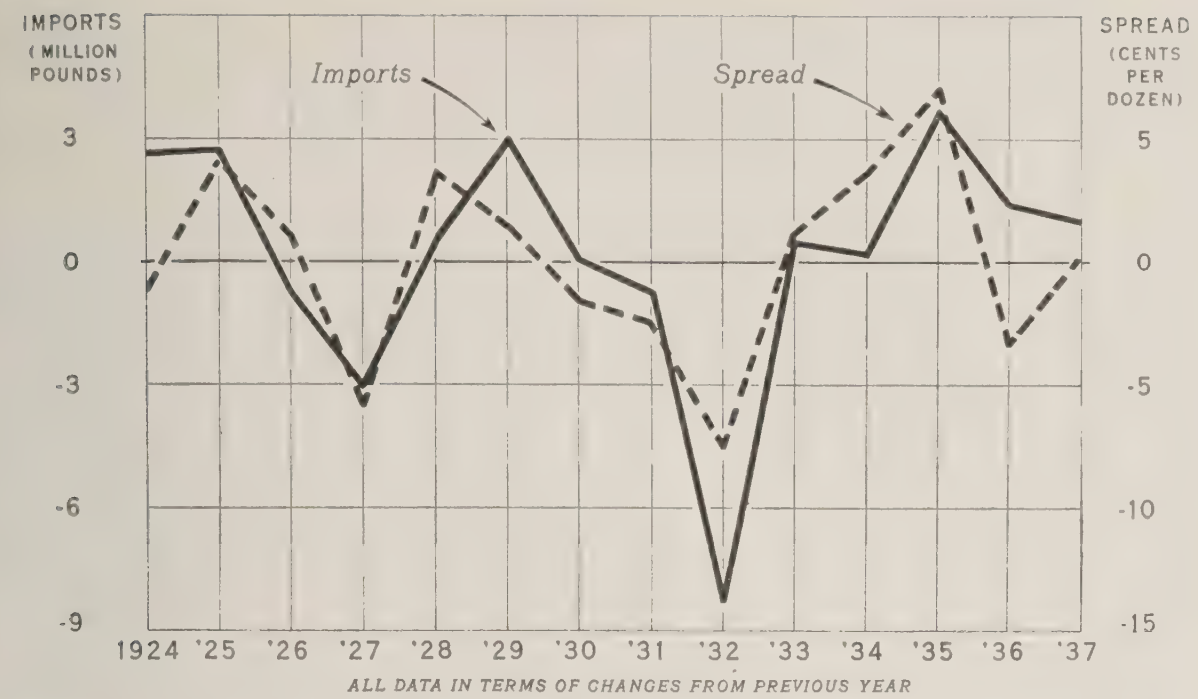

FIGURE 12.—Total imports for consumption of dried-egg products, and spread between Shanghai and United States shell-egg prices, 1923–37. During the past 14 years, when the spread between United States farm egg prices and the Shanghai wholesale shell-egg price has shown an increase, the imports of dried-egg products have nearly always increased. When this spread has decreased imports also have decreased. See table V in appendix A.

TABLE 14.—*Shanghai wholesale price per pound of dried yolk, first quality*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1925	24.9	23.7	22.0	20.9	23.4	------	23.0	25.2	25.0	24.5	25.0	28.1	24.2
1926	27.2	33.2	29.4	26.6	27.5	35.2	34.8	36.1	35.0	37.8	42.3	44.2	34.1
1927	45.1	47.8	40.8	41.4	48.3	49.4	44.4	41.7	43.6	45.7	47.0	45.9	45.1
1928	46.9	47.3	47.3	40.6	43.4	------	41.8	41.7	41.8	42.7	44.6	45.8	44.0
1929	44.5	43.4	48.1	48.7	46.7	45.3	42.5	42.4	43.1	42.9	42.9	43.1	44.5
1930	41.7	40.6	39.6	34.6	30.5	25.6	24.1	25.1	25.0	26.0	23.9	25.6	30.2
1931	23.6	23.9	22.2	18.7	17.4	16.4	18.0	17.2	17.2	18.6	21.7	24.2	19.9
1932	24.7	23.4	21.4	18.8	15.5	12.7	9.9	10.3	10.3	10.1	9.9	9.3	14.7
1933	9.4	9.5	9.8	------	------	8.6	9.7	9.3	9.8	9.8	10.9	11.0	9.8
1934	11.2	11.3	11.4	11.3	10.7	10.9	11.2	11.5	11.7	11.4	11.0	11.3	11.2
1935	11.6	12.1	12.6	12.8	16.6	15.8	15.7	16.0	16.9	18.2	18.9	18.8	15.5
1936	18.9	12.3	13.4	13.8	15.6	14.6	14.6	14.6	14.4	16.5	15.5	15.5	15.0
1937	16.7	16.6	16.7	16.7	17.9	16.7	------	------	------	------	------	------	------

An Analysis of Shanghai Commodity Prices, 1923–32, and Shanghai Market Prices Report. For prices since 1932, see Prices and Price Indexes in Shanghai. All publications issued by the National Tariff Commission, Shanghai, China. Chinese quotations were converted to United States currency with the monthly average exchange rate furnished by Federal Reserve Board.

TABLE 15.—*Shanghai wholesale price per pound of crystal albumen, without zinc*

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1925	90.4	96.0	81.4	76.9	87.4	------	89.6	89.6	88.9	81.8	76.8	77.5	85.1
1926	71.5	71.9	67.9	66.7	63.0	67.7	71.7	65.9	64.9	56.7	56.8	57.5	65.2
1927	60.1	64.6	59.0	60.0	61.1	63.5	59.3	58.0	52.6	52.9	55.3	62.2	59.0
1928	50.9	50.4	46.1	47.4	51.8	52.2	------	45.1	44.0	43.7	45.6	45.8	47.5
1929	45.4	44.8	43.9	47.3	44.7	41.2	41.6	40.2	37.4	39.0	44.7	42.3	42.7
1930	42.2	42.1	39.6	35.7	31.8	25.0	28.0	30.1	31.2	32.6	29.1	25.6	32.8
1931	23.2	22.5	26.4	28.2	26.2	25.4	25.0	23.4	27.6	25.1	42.2	44.3	28.3
1932	37.0	------	38.8	38.1	36.6	36.8	40.2	41.1	41.3	44.2	45.1	39.3	39.9
1933	39.8	40.1	37.5	37.3	41.2	46.1	49.9	45.3	47.9	49.2	58.4	57.1	45.8
1934	55.5	55.3	51.7	49.9	46.3	46.2	45.8	45.8	46.0	44.9	44.2	44.9	48.0
1935	45.9	49.3	51.1	45.4	50.9	48.5	43.5	42.9	45.7	45.4	38.9	42.4	45.8
1936	40.5	39.9	40.3	42.4	39.6	39.0	39.6	37.2	34.8	35.2	35.4	36.5	38.4
1937	39.4	37.7	36.7	35.7	35.8	34.0	------	------	------	------	------	------	------

An Analysis of Shanghai Commodity Prices, 1923–32, and Shanghai Market Prices Report. For prices since 1932, see Prices and Price Indexes in Shanghai. All publications issued by the National Tariff Commission, Shanghai, China. Chinese quotations were converted to United States currency with the monthly average exchange rate furnished by Federal Reserve Board.

TABLE 16.—*Prices per pound of imported dried yolk at New York City, duty paid* [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1921	38.0	32.0	28.0	30.0	30.0	30.0	30.0	30.0	32.0	32.0	32.0	32.0	31.3
1922	42.0	42.0	42.0	34.0	34.0	35.0	40.0	40.0	42.0	42.0	42.0	42.0	39.8
1923	42.0	50.0	48.0	50.0	52.0	58.0	58.0	58.0	58.0	58.0	58.0	58.0	54.0
1924	58.0	58.0	58.0	55.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	53.8
1925	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	52.0	58.0	52.5
1926	57.5	56.9	55.0	55.0	55.0	55.0	55.0	55.0	65.0	70.0	70.0	72.9	60.2
1927	73.0	75.8	85.6	87.5	87.5	87.5	87.5	85.5	82.5	77.5	78.8	79.0	82.3
1928	79.0	78.5	78.0	76.2	76.0	76.6	80.5	78.1	76.0	75.6	77.0	80.5	77.7
1929	80.5	80.0	80.5	81.4	83.0	81.5	78.2	77.0	77.0	77.0	77.0	78.0	79.3
1930	78.8	79.0	80.5	75.9	71.0	66.9	62.0	59.2	60.5	59.8	60.0	59.7	67.8
1931	57.5	54.5	52.6	51.8	48.8	48.4	53.5	53.5	51.8	50.0	57.2	60.0	53.3
1932	60.0	54.0	53.0	50.0	47.8	45.9	42.5	42.5	42.5	46.0	45.2	43.6	47.8
1933	42.5	42.2	45.2	45.5	42.4	42.5	43.5	43.2	43.0	43.0	43.0	43.0	43.2
1934	43.2	44.2	44.5	44.5	44.2	43.5	43.5	43.5	46.0	46.0	45.2	47.0	44.6
1935	47.5	48.0	48.9	52.2	55.0	54.0	52.1	51.5	52.7	55.2	56.8	56.6	52.5
1936	54.5	52.2	52.0	51.0	50.0	50.0	50.2	51.0	51.0	51.0	52.5	53.2	51.6
1937	54.2	54.5	54.9	56.5	56.5	56.5	53.8	55.5	59.5	60.0	60.0	60.0	56.8

[1] Average of weekly prices reported by Oil, Paint, and Drug Reporter. Prices for 1921 through 1925 obtained from Division of Statistical and Historical Research, Bureau of Agricultural Economics.

TABLE 17.—*Prices per pound of imported dried albumen at New York City, duty paid* [1]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Av.
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1921	51.0	52.0	50.0	48.0	48.0	50.0	52.0	58.0	61.0	62.0	72.0	72.0	56.3
1922	71.0	69.0	73.0	68.0	72.0	74.0	78.0	78.0	75.0	80.0	80.0	80.0	74.8
1923	82.0	84.0	95.0	98.0	108.0	112.0	112.0	108.0	108.0	109.0	114.0	117.0	103.9
1924	122.0	122.0	122.0	119.0	119.0	119.0	119.0	119.0	123.0	128.0	135.0	136.0	123.6
1925	132.0	132.0	132.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0	122.0	118.0	124.2
1926	117.5	110.0	105.4	102.6	98.7	97.5	96.5	97.1	96.8	97.2	97.3	96.2	101.1
1927	86.0	87.8	92.5	94.2	97.0	97.0	92.4	88.5	88.0	86.0	85.5	85.0	90.0
1928	85.0	82.5	81.5	80.5	80.5	82.5	82.5	82.5	82.5	80.5	80.5	80.5	81.8
1929	80.5	79.9	81.0	81.0	81.0	79.5	77.9	77.0	76.8	76.5	76.5	76.5	78.7
1930	73.0	73.0	73.5	75.5	75.5	75.5	75.5	75.5	61.5	58.2	55.0	55.0	68.9
1931	55.0	55.0	55.0	55.0	55.0	55.1	59.5	59.5	59.5	64.0	79.3	89.5	61.8
1932	89.5	85.6	88.0	84.8	79.8	79.0	81.0	78.8	78.5	82.6	82.5	81.0	82.6
1933	79.8	78.8	79.4	75.0	79.7	80.5	82.1	82.5	82.5	83.3	85.4	86.0	81.2
1934	88.4	90.5	92.0	92.4	91.4	87.9	87.0	87.0	87.0	87.0	84.0	83.0	88.1
1935	83.0	83.0	84.0	86.4	90.0	90.0	85.0	83.2	83.8	86.0	85.2	83.0	85.2
1936	82.5	80.2	80.0	80.0	80.0	80.0	80.0	79.6	79.0	79.0	78.6	78.0	79.7
1937	78.8	78.5	77.2	77.2	76.5	76.5	74.2	76.5	83.8	85.0	85.0	85.0	79.5

[1] Average of weekly prices reported by Oil, Paint, and Drug Reporter. Prices for 1921 through 1925 obtained from Division of Statistical and Historical Research, Bureau of Agricultural Economics.

THE TARIFF AND OTHER RESTRICTIONS ON DRIED-EGG IMPORTS

Since the World War the poultry industry has requested and obtained increasingly high tariff duties on shell eggs as well as on dried- and frozen-egg products. These increases have been enacted for the purpose of placing the domestic-egg and egg-products industries in a competitive position with the imported products which have lower production costs. Table 18 shows the tariff history of shell eggs and dried-egg products from 1883 to date. In the Tariff Acts of 1883, 1890, and 1894, dried whole egg was dutiable under the general clause that placed a duty of 20 percent ad valorem on all products not specifically provided for. The same clause applied to dried yolk under the Tariff Act of 1883. In all other cases specific duty rates were applied to each of the items shown in the table.

Since July 1931, when the present rate of 27 cents per pound was put into effect, the duty on dried albumen has been equivalent to an ad valorem rate ranging from 41 percent to as much as 83 percent,

while the duty on dried yolk, on the same basis, has been much higher, ranging from 82 percent to as high as 178 percent. These ad valorem rates have been calculated from the prices of dried albument and yolk, less the duty, as shown in tables 16 and 17.

TABLE 18.—*Tariff history of shell eggs and dried-egg products*

Tariff Act of—	Shell eggs	Dried whole egg	Dried yolk	Dried albumen
	Cents per dozen	*Percent ad valorem*	*Percent ad valorem*	*Cents per pound*
1883	Free	20	20	Free
1890	0.05	20	25	Free
			Cents per pound	
1894	.03	20	[1] 0.03	Free
			Percent ad valorem	
1897	.05	25	25	0.03
		Cents per pound		
1909	.05	0.15	25	.03
1913	Free	.10	10	.03
			Cents per pound	
1922	0.08	.18	0.18	.18
1930	.10	.18	.18	.18
1931 [2]	.10	.27	.27	.27

[1] Duty on dried yolk declared, by similitude, to be 3 cents per equivalent of 1 dozen yolks.
[2] On July 24, 1931, a Presidential proclamation became effective increasing the rates on all dried-egg products from 18 cents to 27 cents per pound.

In addition to the tariff, the regulations promulgated by the Food and Drug Administration of the United States Department of Agriculture, concerning the quality and sanitary condition of imported dried eggs, have tended in the past to act as a restriction on the volume of imports. In 1917 domestic importers were informed by the Department of Agriculture that dried-egg products containing more than 100 parts per million of zinc would be considered adulterated within the meaning of the Food and Drug Act, and that shipments of such adulterated foodstuffs would be refused entry into this country. As a result of this ruling, production methods in China have been changed in that, instead of zinc trays, enamelware trays, or the spray method of drying are now used almost exclusively.

When dried egg yolk or whole egg becomes heated or moistened or is allowed to remain in unrefrigerated storage for approximately a year or more, the fats in the material begin to decompose with the development of an acid condition. Investigations have shown that the acidity of the ether extract (fats) is an index of the decomposition of yolk and, although no formal notice has been issued concerning this acidity, the Food and Drug Administration regards the acidity of 5 cc or more of N/20 sodium ethylate per gram of ether extract as being objectionable. An effort to enjoin officials of the Department of Agriculture from applying this determination to egg products resulted favorably to the Government.[23]

During 1936 and 1937, coincident with a rapid increase from extremely low levels in the volume of dried-egg imports, the activities of industry members and groups toward the curtailment of these imports have been in at least four directions. They are (1) legisla-

[23] See notice of judgment, No. 20149.

tion introduced in Congress proposing excise taxes on imported egg products, (2) proposals from members of the egg-drying industry for benefit payments under section 32 of the 1935 amendments to the Agricultural Adjustment Act which would enable domestically produced dried eggs to compete with the imported products, (3) publicity contending that the domestic product is greatly superior to the imported product, and (4) attempts to obtain legislation in various States restricting the use of imported eggs and egg products or requiring labels saying that the products were produced in foreign countries. Each of the methods above will be discussed separately.

(1) **Excise Taxes.**—During the first few months of 1937 several excise tax bills were introduced in Congress. Excise taxes were proposed on all dried-egg products as well as on frozen yolk and whole egg. None of these bills has been enacted into law.

(2) **Benefit Payments.**—Proposals were made in 1936 and 1937 by members of the domestic egg-drying industry to the effect that the Agricultural Adjustment Administration should make benefit payments to egg driers to enable them to compete with the imported products. The programs were not approved because of a lack of assurance that egg producers would obtain direct benefits from the operation of the programs, and also because of the possible undesirable effect such programs might have on our trade relations with China.

(3) **Adverse Publicity.**—For years there has been a more or less steady stream of publicity appearing in various poultry magazines and trade papers criticizing the admission into this country of dried-egg products especially from China. Two opinions seem to be quite general throughout the whole poultry industry: (*a*) That a great many of the ills and troubles that have beset the poultry industry in recent years are traceable to the "tremendous" imports of Chinese dried eggs; and (*b*) that all Chinese egg products are quite rotten and putrid, and are not fit for human consumption. The question of the effect of dried-egg imports on the poultry industry is discussed in a later section of this report.

The United States Tariff Commission [24] is the authority for the following statement concerning egg quality:

> Eggs of the average quality actually used for freezers in the United States would, if used for egg drying, furnish a product like or similar in quality to the dried-egg products imported from China, considered as a whole. In China, owing to primitive methods of transportation, when shell eggs reach drying plants in the treaty ports, they are "so far from the nest" in point of time that only selected, carefully graded eggs can be used by such plants. The egg driers at interior points, which turn out about one-half of the Chinese output, are not under the same necessity and use breaking stock of lower quality.

Dr. W. F. Ferger of the United States Department of Agriculture made a study in 1935, with the help of officials in the Food and Drug Administration, of complaints received concerning the unhealthful condition of our imports of Chinese frozen eggs. The complaints studied alleged that large numbers of bacteria were present in samples of frozen eggs, and that these bacteria were largely pathogenic. His conclusions were that the number of bacteria found was not large; in fact, it was quite small when compared to other samples which were considered edible. He also refuted the statement that the bacteria found were largely pathogenic.

[24] Report to the President on Dried Egg Products. Report No. 25, second series, June 16, 1931, p. 9.

In 1931 the Chinese National Government established the Government Testing Bureau at Shanghai for the purpose of inspecting and testing certain products (including eggs and egg products) prior to the issuance of export certificates for them. Dr. V. Tsai, Commissioner of the Bureau, has written the following in connection with eggs and egg products.[25]

> In view of the importance of Chinese egg exports, the Chinese National Government has initiated a registration system of all the egg factories in this country, and only those possessing the required equipment and complying with the cleanliness stipulated, are allowed to register and apply for inspection or exportation. Besides the regular periodical visits to all factories, the inspection process includes a thorough physical, chemical, and bacteriological examination of the eggs, and permission for export is strictly withheld on those failing to pass the standards prescribed by the Ministry of Industry. In view of the stringent measures adopted in carrying out the inspection, it is small wonder that the foreign specialists should have failed to find any defects in the Chinese egg. In the past Chinese eggs have suffered somewhat from delay due to inadequate transportation from the interior to the egg factories but of late there has been a decided improvement as a result of the inauguration of the through traffic system by the Ministry of Railways by which the eggs are brought to the shipping centers with a minimum of delay. Under the present system, eggs can now be delivered to the packing plants in a fresh condition with a remarkably low percentage of rejects.

The Food and Drug Administration has full control of the examination of imported egg products and makes these examinations as a matter of routine. It makes the same type of examination of the products of domestic manufacturers but it has no power to inspect the plants unless the owners voluntarily consent. It has power to examine products only after they have entered interstate commerce and this inspection must be on a project or sampling basis because of technical and financial limitations. There would appear to be at least as good inspection of imported products as of domestically produced egg products.

It should be pointed out that there appears to be a definite relationship between the relative prosperity of the poultry industry and the volume of publicity appearing in the press attacking our Chinese imports. Other factors that may be causing hardship and loss of profits in the poultry industry are often ignored, and the blame is placed on the volume of imports that are alleged to be the cause of low prices for domestic shell eggs.

(4) **State Legislation.**—Efforts are continuing to be made in several States to obtain legislation that will restrict the use of imported eggs and egg products by either banning their use entirely or by requiring the labeling of all food products containing imported eggs. Bills have been introduced in some States and demands have been made on the part of interested groups for the introduction of similar bills in other States.

COSTS OF PRODUCING DRIED-EGG PRODUCTS IN THE UNITED STATES

SHELL-EGG COST

All other costs of producing dried-egg products are unimportant as compared to the cost of the raw material—shell eggs. This is the reason why China can compete with the United States' egg-drying

[25] The Inspection and Commerce Journal, vol. VI, Sept.–Oct. 1935, Government Testing Bureau, Shanghai, China.

industry even when the tariff on the imported product is as much as 100 percent on an ad valorem basis; it is the reason why Texas has been the State with the largest production of dried eggs; and it is also the reason why, prior to the World War, some firms used eggs of questionable quality, with consequent governmental investigation and litigation. Manufacturing costs and overhead represent not more than 10 percent of the total cost of the final product even when shell-egg prices are very low. Evidence supporting the importance of the cost of raw materials has been presented in detail in the section on International Trade in Dried-Egg Products, where a comparison is made between prices of shell eggs in this country and in China.

The cost of shell eggs is, of course, dependent on a number of factors. Not only will egg prices vary widely from season to season and from year to year with changes in supply and demand conditions, but they will show wide variations between different sections of the United States, and will also vary according to the quality of eggs purchased. In the following section of this study, an analysis will be found of the factors influencing changes in the farm price of eggs from 1920 through 1936. Each year these factors play an important part in determining whether or not egg products can be dried profitably in the United States. When shell-egg prices are extremely low because of reduced consumer purchasing power, as in 1932 and 1933, a decided impetus is given to the domestic egg-drying business. When egg prices are at high levels, either because of a high purchasing power or during the fall and winter months when egg prices are seasonally high, the producer of dried eggs cannot operate profitably.

COST OF LIQUID EGG PRIOR TO DRYING

In addition to the plant delivered price of shell eggs, egg driers must consider the cost of candling eggs in order to discard those unfit for drying, the cost of breaking the usable eggs, and the cost of separating albumen from the yolks when these products are to be dried separately. These are the costs which egg-breaking operations entail, whether for drying or freezing purposes.

The cost of candling shell eggs varies with the season of the year, with the quality of the eggs being handled, and with the degree of accuracy desired in the candling process. During hot weather, or in a locality where a large proportion of the eggs are unsatisfactory, candling costs are higher than when the eggs are running uniformly good with only an occasional bad one. If only a rapid candling or "flashing" is required in order to discard "rots" and "bloodspots," the candling cost will be relatively low as compared to the cost of separating the eggs into grades. In the former case a candler can handle at least 50 percent more eggs per day than in the latter case.

The cost of candling eggs, as reported by various egg driers, ranges from 8 to 15 cents per case. A low cost of 8 cents per case could be obtained only when the eggs were "flashed," and not when a careful candling was given. On the basis of reports received it would be fair to assume that in the spring of the year candling, according to the present practice of egg driers, costs an average of 10 cents per case. In hot summer weather this cost would be increased to approximately 15 cents, but the largest proportion of eggs used

for drying are purchased in the spring. If the eggs were to be graded and only those of specific qualities used for drying purposes, candling and grading costs might be increased to as much as 20 cents per case.

Egg-breaking costs appear to vary considerably. The United States Tariff Commission states:[26] "It costs 1.9 cents per pound to remove meats from the shell." This cost, as reported by various egg driers in 1936, varies from 30 to 70 cents a case, these costs including all supplies, labor, rent, power, and equipment. It can be assumed that a cost of 50 cents a case is representative.

There is an additional expense for separating when the yolk and albumen are to be dried separately, since the largest single expense item in the cost of breaking eggs is labor. An egg breaker can handle at least 50 percent more eggs when they are to be used as liquid whole egg. This additional expense for separation as reported by various egg driers approximates 10 cents per case of eggs handled.

The figures above, including all items of expense incurred in connection with mixing, straining, and placing the liquid egg in the proper containers, may be summarized as follows:

	Cents per case	*Cents per pound*
Candling cost	10.0	0.286
Breaking cost	50.0	1.429
Separating cost	10.0	.286
Total	70.0	2.001

While these figures are somewhat lower than the average reported by several firms in the drying business, there is at least one firm operating on a fairly large scale which reports that it can prepare eggs for drying, including "labor, rent, electricity, power, heat, and office overhead required to handle the shell eggs, candle them, break them, and separate them, mix them and place them in the proper containers," for 1.5 cents per pound.

From the cost figures as given above, table 19 has been prepared to show what the cost of liquid whole egg would be assuming various prices of shell eggs.

TABLE 19.—*Cost of liquid whole egg for drying purposes at various levels of shell-egg prices*

Plant-delivered cost of shell eggs [1]		Candling and breaking cost (cents per case)	Cost of liquid whole egg [2]	
Dollars per case	Cents per dozen		Dollars per case	Cents per pound
$3.00	10.0	60.0	$3.60	10.3
3.30	11.0	60.0	3.90	11.1
3.60	12.0	60.0	4.20	12.0
3.90	13.0	60.0	4.50	12.9
4.20	14.0	60.0	4.80	13.7
4.50	15.0	60.0	5.10	14.6
4.80	16.0	60.0	5.40	15.4
5.10	17.0	60.0	5.70	16.3
5.40	18.0	60.0	6.00	17.1
5.70	19.0	60.0	6.30	18.0
6.00	20.0	60.0	6.60	18.9

[1] 1 cent is usually added to the farm price for delivering to plant.
[2] Cost per pound is based on average of 35 pounds of liquid whole egg per 30-dozen case.

[26] Report to the President on Dried Egg Products. Report No. 25, second series, June 16 1931, p. 11.

DRYING, PACKING, AND SHIPPING COSTS

There are fairly wide variations in the cost of egg drying as reported by different firms. These variations may be due to efficiency in the use of plant equipment, such as would be represented by a firm which had continuous operation throughout the season, or by a firm which had a constant demand for either liquid yolk or liquid albumen, thus making adjustments to the sale of the least popular item unnecessary. Other variations might be due to the actual type of equipment used or to the skill of plant operation, and still others might be due to the refinements used in the drying process. These cost variations might be accompanied by similar variations in sales prices.

The average cost of drying whole egg for two firms which did most of the drying of this product and which reported the most complete figures (in one case both 1935 and 1936 figures were used and in the other instance only 1936) was 3.41 cents per pound. These same firms reported an average cost of containers and liners for the same years of 0.51 cent per pound. These cost figures are comparable with those reported by the Tariff Commission [27] of 3.9 cents per pound for the cost of drying whole egg, and 1.1 cents per pound for containers and liners.

The average cost of drying yolk as reported by three firms which did most of the drying of this product and which reported complete figures (in all cases figures being based on 1936 operations) was 2.87 cents per pound. Containers and liners used by these same firms were valued at 0.58 cent per pound. These two figures are comparable with similar ones reported by the Tariff Commission [28] of 3.3 cents per pound and containers valued at 1.1 cents per pound.

The two firms doing most of the drying of albumen and reporting complete figures on these operations (one being for 1934 as well as 1936 operations and the other being for 1936) reported an average drying cost per pound of 8.23 cents. The containers used for dried albumen were reported to have cost 0.53 cent per pound. The Tariff Commission [29] reported the cost of drying albumen as being 11.2 cents per pound with containers and liners costing an additional 1.1 cents per pound.

It will be seen from the comparisons shown above that container costs have been cut practically in half since the Tariff Commission obtained the data for its report in 1931. It is also apparent that costs of producing all of the various dried-egg products are now somewhat lower than those reported by the Tariff Commission although, except in the case of albumen, these differences are not particularly significant. In the case of dried albumen technical improvements have been made during recent years which have materially reduced the cost of drying this product.

In addition to the costs shown above, it is necessary to consider transportation costs to New York City in order to compare the price of domestically produced products with those imported from for-

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[27] Report to the President on Dried Egg Products Report No. 25, second series, June 16, 1931, p. 12

[28] Ibid.

[29] Ibid.

eign countries, as New York City is the port of entry in nearly all cases. This and other Eastern cities also receive most of the domestically produced products. From the reports received from egg driers it can be estimated that at least 75 percent of the eggs dried in this country are shipped to New York City or other Eastern points, the balance usually going to Chicago or Pacific coast cities. The Tariff Commission reports that [30] "More than two-thirds of the total imports for consumption during 1930 were entered at the port of New York and virtually all the entries through that port are merchandised in the New York market." The railroad freight cost on dried-egg products from points in Texas, Missouri, or Oklahoma, to New York City, as furnished by railroad companies in March 1936, was 1.35 cents per pound.

On the basis of the costs described above and the preceding material on conversion factors and costs of breaking eggs, it is now possible to prepare tables showing the approximate cost of dried-egg products at various levels of shell-egg prices. First, it will be desirable to tabulate the drying-cost figures, including freight and containers, and these figures can then be added to the other costs. This tabulation is shown in table 20.

TABLE 20.—*Cost of drying eggs in the United States in 1936*

	Whole egg	Albumen	Yolk
	Cents per pound	*Cents per pound*	*Cents per pound*
Drying cost	3.41	8.23	2.87
Containers	.51	.53	.58
Freight	1.35	1.35	1.35
Total cost	5.27	10.11	4.80

Tables 21, 22, and 23 show the estimated cost of domestic dried-egg products per pound delivered at New York City at various levels of shell-egg prices at producing points. From these tables it is possible to estimate what the price of shell eggs would have to be in order for domestically produced dried-egg products to compete successfully with imported products at various prices.

In determining the cost of either dried yolk or dried albumen it is necessary to take into consideration the value of the remaining part of the egg which is not dried simultaneously. That is, if albumen is being dried the cost of the finished product will be much less if liquid yolk can be sold for 40 cents instead of 15 cents per pound, and if yolk is being dried the cost of the finished product in this instance too will depend to a considerable extent on the price which can be obtained for the liquid albumen. For this reason tables 22 and 23 are set up to show variations in costs of dried-egg products, not only on the basis of differences in shell-egg prices, but also on the basis of differences in values of liquid yolk and albumen.

[30] Report to the President on Dried Egg Products. Report No. 25, second series, June 16, 1931, p. 9.

TABLE 21.—*Cost of domestically produced dried whole egg at various levels of shell-egg prices*

Plant-delivered cost of shell eggs	Shell-egg cost plus 2 cents candling and breaking cost	Cost of liquid whole egg	Liquid cost converted to dried form	Drying cost (including freight and containers)	Total cost
(1)	(2)	(3)	(4)	(5)	(6)
Cents per dozen	*Cents per dozen*	*Cents per pound*	*Cents per pound*	*Cents per pound*	*Cents per pound*
10	12	10.285	36.7174	5.27	41.9874
11	13	11.142	39.7769	5.27	45.0469
12	14	12.000	42.8400	5.27	48.1100
13	15	12.857	45.8994	5.27	51.1694
14	16	13.714	48.9590	5.27	54.2290
15	17	14.571	52.0184	5.27	57.2884
16	18	15.428	55.0780	5.27	60.3480
17	19	16.285	58.1374	5.27	63.4074
18	20	17.142	61.1969	5.27	66.4669
19	21	18.000	64.2600	5.27	69.5300
20	22	18.857	67.3195	5.27	72.5895

(1) Assumed levels of prices for plant-delivered shell eggs.
(2) Column 1 plus 10 cents a case candling cost and 50 cents breaking costs.
(3) Column 2 divided by 1.1667, which is the average yield in liquid whole egg from 1 dozen eggs.
(4) Column 3 multiplied by 3.57, which is the average number of pounds of liquid whole egg required to make 1 pound of dried eggs.
(5) Drying cost per pound, made up of 3.41 cents drying cost, 0.51 cent for containers, and 1.35 cents for transportation cost to New York City.
(6) Total dried-egg cost for varying values of shell eggs.

TABLE 22.—*Cost of domestically produced dried yolk at various levels of shell-egg prices and wholesale frozen-albumen prices*

Wholesale prices of frozen albumen	Price per pound of dried yolk delivered at New York City for various shell-egg prices in cents per dozen										
	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
Cents per pound	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
7	37.6	41.5	45.9	50.3	54.2	58.6	62.5	66.9	70.8	75.2	79.6
8	35.1	39.0	43.4	47.8	51.7	56.1	60.0	64.4	68.4	72.8	77.2
9	32.2	36.1	40.5	44.9	48.8	53.2	57.1	61.5	65.4	69.8	74.2
10	29.7	33.6	38.0	42.4	46.4	50.8	54.7	59.1	63.0	67.4	71.8
11	26.8	30.7	35.1	39.5	43.4	47.8	51.7	56.1	60.0	64.4	68.8
12	24.4	28.3	32.7	37.1	41.0	45.4	49.3	53.7	57.6	62.0	66.4
13	21.4	25.3	29.7	34.1	38.0	42.4	46.4	50.8	54.7	59.1	63.5
14	19.0	22.9	27.3	31.7	35.6	40.0	43.9	48.3	52.2	56.6	61.0
15	16.0	20.0	24.4	28.8	32.7	37.1	41.0	45.4	49.3	53.7	58.1
16	13.6	17.5	21.9	26.3	30.2	34.6	38.5	42.9	46.8	51.2	55.6
17	10.7	14.6	19.0	23.4	27.3	31.7	35.6	40.0	43.9	48.3	52.7
18	8.2	12.1	16.5	20.9	24.8	29.2	33.2	37.6	41.5	45.9	50.3
19	5.3	9.2	13.6	18.0	21.9	26.3	30.2	34.6	38.5	42.9	47.3
20	-------	6.8	11.2	15.6	19.5	23.9	27.8	32.2	36.1	40.5	44.9
21	-------	-------	8.2	12.6	16.5	20.9	24.8	29.2	33.2	37.6	42.0
22	-------	-------	5.8	10.2	14.1	18.5	22.4	26.8	30.7	35.1	39.5
23	-------	-------	-------	7.2	11.2	15.6	19.5	23.9	27.8	32.2	36.6
24	-------	-------	-------	-------	8.7	13.1	17.0	21.4	25.3	29.7	34.1
25	-------	-------	-------	-------	5.8	10.2	14.1	18.5	22.4	26.8	31.2
26	-------	-------	-------	-------	-------	7.7	11.6	16.0	20.0	24.4	28.8

NOTE.—Since approximately 55 percent of an egg is albumen, it is assumed that 55 percent of the figure in the left-hand column is obtained from the sale of albumen and this amount is subtracted from the price of liquid whole egg to obtain the value of liquid yolk in 1 pound of liquid whole egg. This figure is then divided by 0.45 to obtain the value of 1 pound of liquid yolk when the albumen has been sold at the price shown in the left-hand column.

The value of liquid yolk per pound is then converted to a dry basis by multiplying by 2.2, which is the average number of pounds of liquid yolk required to make 1 pound of dried yolk. Drying cost, including containers and transportation to New York City, of 4.80 cents per pound has been added.

TABLE 23.—*Cost of domestically produced dried albumen at various levels of shell egg prices and wholesale frozen yolk prices*

Wholesale prices of frozen yolk	Price per pound of dried albumen delivered at New York City for various shell-egg prices in cents per dozen										
	10.0	11.0	12.0	13.0	14.0	15.0	16.0	17.0	18.0	19.0	20.0
Cents per pound	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
15	60.5	71.2	83.1	95.1	105.7	117.6	128.2	140.2	150.8	162.7	174.7
16	55.2	65.9	77.8	89.7	100.4	112.3	122.9	134.9	145.5	157.4	169.4
17	48.6	59.2	71.2	83.1	93.7	105.7	116.3	128.2	138.9	150.8	162.7
18	43.3	53.9	65.9	77.8	88.4	100.4	111.0	122.9	133.5	145.5	157.4
19	36.7	47.3	59.2	71.2	81.8	93.7	104.3	116.3	126.9	138.9	150.8
20	31.3	42.0	53.9	65.9	76.5	88.4	99.0	111.0	121.6	133.5	145.5
21	24.7	35.3	47.3	59.2	69.8	81.8	92.4	104.3	115.0	126.9	138.9
22	19.4	30.0	42.0	53.9	64.5	76.5	87.1	99.0	109.7	121.6	133.5
23	12.8	23.4	35.3	47.3	57.9	69.8	80.5	92.4	103.0	109.7	121.6
24	-------	18.1	30.0	42.0	52.6	64.5	75.1	87.1	97.7	109.7	121.6
25	-------	11.4	23.4	35.3	45.9	57.9	68.5	80.5	91.1	103.0	115.0
26	-------	-------	18.1	30.0	40.6	52.6	63.2	75.1	85.8	97.7	109.7
27	-------	-------	11.4	23.4	34.0	45.9	56.6	68.5	79.1	91.1	103.0
28	-------	-------	-------	18.1	28.7	40.6	51.3	63.2	73.8	85.8	97.7
29	-------	-------	-------	11.4	22.1	34.0	44.6	56.6	67.2	79.1	91.1
30	-------	-------	-------	-------	16.7	28.7	39.3	51.3	61.9	73.8	85.8
31	-------	-------	-------	-------	-------	22.1	32.7	44.6	55.2	67.2	79.1
32	-------	-------	-------	-------	-------	16.7	27.4	39.3	49.9	61.9	73.8
33	-------	-------	-------	-------	-------	-------	20.7	32.7	43.3	55.2	67.2
34	-------	-------	-------	-------	-------	-------	15.4	27.4	38.0	49.9	61.9

NOTE.—Since approximately 45 percent of a liquid whole egg represents yolk, it is assumed that 45 percent of the figure in the left-hand column is obtained from the sale of yolk and this amount is subtracted from the price of liquid whole egg to obtain the value of liquid albumen in 1 pound of liquid whole egg. This figure is then divided by 0.55 to obtain the value of 1 pound of liquid albumen when the yolk has been sold at the price shown in the left-hand column.

The value of liquid albumen per pound is then converted to a dry basis by multiplying by 7.3, which is the average number of pounds of liquid albumen required to make 1 pound of dried albumen. Drying cost, including containers and transportation to New York City, of 10.11 cents per pound has been added.

RELATION OF THE EGG-DRYING INDUSTRY TO THE PRODUCTION AND MARKETING OF EGGS

ECONOMIC IMPORTANCE OF DRIED EGGS

The importance of dried eggs is not based solely on the proportion of all eggs which are consumed in this form since dried-egg products account for only a relatively small proportion of all eggs used. The production of eggs in the United States has been estimated by the Crop Reporting Board of the Bureau of Agricultural Economics to have varied from a little more than 2 billion dozen to a little less than 3 billion dozen eggs annually during the period from 1925 through 1935. The total annual supply of dried eggs, including domestic production and imports, has fluctuated during the same period from an equivalent of 20 to nearly 50 million dozen shell eggs. At the most, then, dried eggs might amount to a little over 2 percent of the total egg supply and at the least something less than 1 percent of the total supply. Usually dried eggs account for approximately 1.5 percent of the supply of eggs consumed in this country.

Dried-egg products are important, however, because they represent a product which is different from shell and liquid eggs and because

they serve a need which other types of eggs cannot meet. The United States Tariff Commission reported:[31]

> Today the trade estimates that nearly 80 percent of the consumption of dried eggs is in the manufacturing of products in which frozen or shell eggs cannot be used.

The Chicago Mercantile Exchange, in discussing uses for frozen and dried eggs, had the following to say:[32]

> Where they are interchangeable, frozen eggs have displaced dried-egg products. Dried eggs are still to be found, however, alongside frozen eggs in small noodle and bake shops, confectioneries, and ice-cream plants, although their uses are now generally confined to prepared flours, baking and whipping powders, prepared animal foods, and technical operations.

It is particularly in the form of prepared doughnut and cake mixes, ice-cream and meringue powders, and in other powdered products that dried eggs have met a need for which frozen or shell eggs cannot be substituted.

The economic importance of dried eggs is determined to a large extent by the physical characteristics of the product itself. It is a food product with valuable properties in highly concentrated and compact form, and, being almost entirely dehydrated, it is not as perishable as shell eggs. While the uses for dried eggs are at the present time somewhat limited, the reason for this is partly the tenacity of customs and habits in the use of food products; and it is entirely conceivable that in the future, with a considerably improved product and better methods of distribution, dried eggs may become a more important type of egg product.

Approximately 306 dozen shell eggs are required to make 100 pounds of dried whole egg, a fact which readily indicates the important savings which can be obtained in storage and transportation costs for dried eggs as compared with shell eggs. In terms of the housewife using eggs, one-fourth of a cup of dried whole egg is the approximate equivalent of five medium-sized eggs. Table 24 shows the savings that might be obtained by drying eggs, storing for 8 months, and shipping to New York as compared to storing and shipping the equivalent amount of shell eggs produced in the Middle West. The cost for dried whole egg also includes the approximate cost of 2-pound containers to package the dried whole egg. This table shows that the drying operations could be carried on with a probable saving amounting to approximately 2.09 cents per dozen, or $6.37 on 306 dozen eggs. There are, however, limiting factors which, in spite of the lower cost of dried eggs, tend to prevent substitution of dried eggs for shell eggs. To the extent that the usableness of the product is less or consumer resistance greater, the advantage of lower costs will be offset and merchandising cost will be increased.

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[31] Report to the President on Dried Egg Products. Report No. 25, second series. June 16, 1931, p. 4.

[32] The Frozen Egg Industry. Chicago Mercantile Exchange, 1937, p. 4.

TABLE 24.—*Comparative costs of storage and transportation to New York City for shell eggs and for dried whole eggs with drying cost included*

Items of cost	Cost per dozen eggs	Cost per 306 dozen eggs [1]
	Cents	*Dollars*
Storing as shell eggs:		
1. Into-storage candling, and packing materials [2]	1.00	3.06
2. Storage charges, warehouse rental, interest, etc., for 8 months [3]	2.70	8.26
3. Out-of-storage candling	.30	.92
4. Loss and depreciation (6 eggs per case at 24 cents per dozen)	.40	1.22
5. Freight to New York City [4]	2.30	7.04
Total cost for storing as shell eggs	6.70	20.50
Drying into whole dried eggs: [5]		
1. Candling and breaking	2.00	6.12
2. All plant costs involved in drying	1.11	3.41
3. Containers (2-pound cans)	.41	1.25
4. Storage charges for 8 months	.65	2.00
5. Freight to New York City	.44	1.35
Total cost for drying as whole eggs	4.61	14.13
Savings obtained by drying into whole eggs	2.09	6.37

[1] 306 dozen eggs will yield 100 pounds of dried whole egg.
[2] Candling costs as shown on p. 33; cases and packing material at 20 cents per case.
[3] Marketing Poultry Products. Benjamin and Pierce, p. 200, 1937.
[4] Carload quantities from Kansas City, Mo.
[5] See pp. 34 through 37.

At the present time the decreased perishability of dried eggs as compared to shell eggs is not considered important because most dried eggs are still consumed within a year after their manufacture. However, if the use of dried whole egg spreads generally to housewives and other small consumers who might not have refrigerating facilities, or if it should become desirable to store large quantities of eggs over long periods of time because of war or other emergencies, then dried whole egg would probably offer distinct advantages as compared to shell eggs and possibly as compared to frozen eggs. Dried-egg products offer the possibility of storing eggs in a small space for a long period of time without refrigeration, provided means are made available for maintaining the proper freeness from moisture.

Domestically produced dried eggs are also said to have a significant influence on egg producers because it is possible to use eggs with inferior exterior qualities for drying purposes. That is, of course, also true in the case of frozen eggs. At the present time most of the shell eggs purchased for either drying or freezing are bought on a "current receipt" basis and are candled only in order to exclude bad eggs. However, there are large quantities of under-grade eggs, particularly "checks" and "dirties," which enter the regular shell-egg trade and which tend to reduce the average price received by producers for all eggs. These eggs might be more valuable to consumers in dried and frozen form than as shell eggs, since deterioration would be less in moving the eggs from the producer to the consumer.

Information received from members of the trade indicates that these so-called under-grade eggs are entirely satisfactory for drying purposes. These eggs are an edible product but represent a food which is not readily merchantable and which does not stand up well during handling through normal shell-egg marketing channels. No figures are available to determine the volume of various quality eggs entering market channels. However, through the cooperation of a

large firm having plants located in the Middle West a report has been received of the receipts of eggs by grade for 1 year, July 1935 to July 1936. This report covers one plant in each of 10 States, namely, Wisconsin, Minnesota, Iowa, Kansas, Oklahoma, Missouri, Illinois, Kentucky, North Dakota, and Nebraska, and represents a sample of over 6 million dozen eggs. The proportion of eggs of different qualities in this sample were as follows:

	Percent
Extras	18
Fresh firsts	37
Firsts	27
Under-grades	18
Total	100

"Extras" and "Fresh firsts" are of such quality as to represent very desirable market eggs which will give satisfaction to consumers for table use or which will be suitable for storing in the shell. "Firsts" can be considered as good edible eggs, but are best used for immediate consumption. "Under-grades" are edible but represent eggs which it would not be desirable to move through regular market channels in shell form, and would be more efficiently used in frozen or dried form.

If it can be assumed that this sample of 6 million dozen eggs is representative of all the eggs marketed and that the sample obtained in 1935–36 is representative of other years, it would then mean that from 250 to 378 million dozen under-grade eggs are available each year. During the period since 1925 from 2 to 3 billion dozen eggs have been produced annually, and normally about 70 percent of the production was sold from farms (69.2 percent in 1933, 70.6 in 1934, and 70.3 in 1935) according to the estimates of the Bureau of Agricultural Economics. The record annual production of frozen eggs in this country up to 1937 was in the neighborhood of 200 million pounds, which would require slightly more than 171 million dozen eggs. It has already been observed that the annual consumption of dried eggs, including imports and domestic production, has never amounted to the equivalent of more than 50 million dozen eggs.

It is, therefore, probable that the supply of under-grade eggs is sufficient to produce all of the frozen- and dried-egg products which might be needed in this country if the eggs were purchased on a graded basis.

DOMESTIC PRODUCTION OF DRIED AND FROZEN EGGS

The supplies and prices of frozen eggs have an important bearing on egg-drying operations and on dried-egg prices. One egg-drying firm breaks shell eggs in order to obtain liquid yolk to be used in the manufacture of mayonnaise, then sells the albumen in either liquid or dried form depending on which will give the largest return. Other egg driers have particular uses for dried yolk, and they may sell the albumen in frozen form. It would be an exceptional circumstance if the demand for liquid yolk were just the same as the demand for the liquid albumen that might be obtained from the same shell eggs. Actually, there usually appears to be an excess of liquid albumen, and any new uses or outlets which could be found for either liquid or dried albumen would materially benefit the poultry industry.

There has been a consistent and rapid growth in the domestic production of frozen eggs from the period following the World War until the present time. This can be readily seen from table 25, which shows the cold-storage holdings of all frozen egg products on the first day of each month from 1917 through 1937. There was some decline in the amount of frozen eggs in storage during the recent depression years, but this loss has been recovered and the production of frozen eggs reached an all-time peak in 1937. The peak of storage holdings is usually reached on August 1, and while this figure will by no means represent all the frozen eggs which have been produced during the previous spring months, changes in storage holdings from one year to the next at this time should indicate quite closely the proportionate changes which have taken place in the production of these egg products. In 1916 frozen-egg storage holdings on August 1 amounted to 2.7 percent of the holdings of all eggs, while by 1937 frozen-egg holdings amounted to more than one-third of all the eggs in storage. Technological improvements in the egg-breaking and egg-freezing industry as well as the increased sales of bakery products by large concerns have accelerated the use of frozen eggs. Part of this increase has been at the expense of dried-egg products and at the expense of imports of frozen and shell eggs, but some of it has undoubtedly been due to a widening use for egg products.

TABLE 25.—*Frozen eggs: Cold-storage holdings as of the first of each month*

[In thousands of pounds, i. e., 000 omitted]

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1916	-------	-------	-------	-------	3,133	4,176	5,410	5,822	5,223	6,457	6,307	5,104
1917	2,737	1,724	1,334	2,394	3,329	7,558	13,398	15,384	19,741	17,585	16,424	13,979
1918	14,603	12,207	9,746	9,001	9,488	11,555	12,895	15,240	15,871	14,757	13,281	11,832
1919	8,980	7,760	6,931	5,989	8,046	11,568	16,472	19,024	21,017	20,687	18,976	22,690
1920	19,286	16,394	13,836	11,039	10,529	13,939	17,388	20,055	21,901	23,584	20,461	29,945
1921	27,325	24,927	22,363	20,873	21,730	26,822	27,737	27,952	27,408	26,656	26,114	22,899
1922	19,260	16,209	13,193	10,473	14,154	18,273	23,528	27,855	34,516	33,545	30,523	26,233
1923	22,787	18,517	14,603	10,311	12,921	20,730	29,686	36,192	37,280	43,836	40,424	36,004
1924	32,087	27,682	23,106	20,736	23,707	29,956	33,565	35,184	34,128	31,006	26,633	22,100
1925	21,303	16,292	11,364	11,353	19,579	29,544	38,379	42,855	47,099	44,299	45,314	39,336
1926	33,905	29,256	24,167	21,849	25,739	34,815	45,688	51,810	52,634	51,062	44,966	38,620
1927	33,593	31,207	26,053	33,272	52,053	71,605	81,263	81,418	77,508	71,208	62,066	54,703
1928	47,020	38,575	31,362	34,411	51,532	67,941	77,744	81,670	89,196	82,255	73,327	64,201
1929	56,181	48,055	38,250	34,918	51,825	71,560	84,766	91,488	86,693	81,541	70,331	61,772
1930	53,644	44,080	35,192	49,751	76,664	106,904	115,134	116,272	113,138	106,631	98,359	89,571
1931	83,184	75,685	73,889	78,051	91,517	106,607	113,513	114,700	110,271	103,302	94,816	86,407
1932	79,198	72,439	68,024	69,031	81,920	94,978	100,485	99,112	92,967	84,187	74,314	64,150
1933	55,339	46,448	40,450	45,090	62,944	85,323	103,019	107,660	102,449	93,182	82,302	72,348
1934	61,419	49,910	39,181	38,679	62,632	93,947	116,058	121,564	111,994	99,951	88,715	76,073
1935	64,879	52,726	39,413	39,516	59,313	84,680	107,937	116,274	112,585	98,653	88,018	79,035
1936	69,546	59,722	46,367	45,848	69,172	94,014	111,725	115,485	108,614	96,660	82,011	66,279
1937	51,837	39,104	34,390	53,074	88,186	133,132	164,830	166,876	160,258	148,216	133,805	120,929

U. S. Department of Agriculture Statistical Bulletin No. 48 and monthly cold-storage reports of the Department.

In 1935 original entries of frozen eggs into cold-storage warehouses amounted to 207,625,000 pounds, or the approximate equivalent of 177,959,000 dozen shell eggs. During the same year dried-egg consumption, including production and imports, amounted to the equivalent of only about 30,347,000 dozen shell eggs.

Table 26 shows the proportion of dried yolk, albumen, and whole egg to the total pounds of dried eggs produced each year in the United States. Since 1927 whole egg has represented only a small proportion of domestically produced dried eggs. However, in the

case of frozen eggs, whole egg represents about one-half of the production. In 1935, 44 firms representing all sections of the country reported that of a frozen-egg production amounting to approximately 149,590,000 pounds, 49.8 percent was whole eggs.[33] The production of frozen albumen amounted to 26.5 percent of the total, and yolk represented 23.7 percent of the total. (On the basis of conversion factors shown on p. 18, if 50 percent of the eggs broken were separated, 27.5 percent would represent albumen and 22.5 percent yolk.) The yolk production of these firms was divided into plain yolk, amounting to 11.4 percent of the total frozen-egg production; salt yolk, 5.1 percent; and sugar yolk, 7.2 percent. No glycerine yolk was reported although it was understood that one firm has a patented process for making this product and produces some each year. Figures on the proportion of whole egg to total frozen-egg production, as given above, are substantiated by figures on the proportion of mixed whole egg, albumen, and yolk in storage on the first of each month, as reported by the Bureau of Agricultural Economics. Table 27, which is divided into three parts, shows the percentage of mixed egg, albumen, and yolk to the total frozen eggs in cold storage on the first day of each month from 1925 through 1937.

TABLE 26.—*Percent of total domestic dried-egg production represented by different dried-egg products, 1927–37*

Year	Percent of yolk to total pounds dried	Percent of albumen to total pounds dried	Percent of whole egg to total pounds dried	Year	Percent of yolk to total pounds dried	Percent of albumen to total pounds dried	Percent of whole egg to total pounds dried
1927	71.1	----------	28.9	1933	58.5	40.0	1.5
1928	98.8	1.2	----------	1934	61.0	32.4	6.6
1929	93.6	4.9	1.5	1935	93.5	4.4	2.1
1930	98.5	----------	1.5	1936	75.5	18.9	5.6
1931	86.6	.3	13.1	1937	74.0	22.9	3.1
1932	81.8	17.6	.6				

TABLE 27.—*Classification of cold-storage holdings of frozen eggs*

PERCENT THAT WHOLE EGG IS OF THE TOTAL HOLDINGS

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1925	47	47	44	47	50	47	50	51	57	52	50	51
1926	48	47	46	45	45	48	51	56	45	56	57	55
1927	53	52	52	45	50	50	50	49	49	49	47	45
1928	42	40	37	44	49	52	54	56	57	57	58	56
1929	54	52	49	44	47	52	57	59	60	60	61	60
1930	60	59	59	58	58	58	59	61	62	62	63	62
1931	63	63	65	64	61	58	58	59	60	59	61	61
1932	61	62	61	64	61	56	52	52	52	52	53	51
1933	50	49	48	48	42	44	46	48	49	49	48	50
1934	49	52	53	52	45	44	45	49	49	50	47	47
1935	47	46	44	41	40	40	43	46	47	47	47	46
1936	47	48	49	51	46	45	43	46	47	47	47	47
1937	45	47	48	48	46	44	44	45	47	47	47	47

[33] The liquid-egg production of 171 firms for the same year amounted to 188,649,082 pounds. See Production of Frozen Eggs in the United States in 1935 [mimeo.]. Poultry Section, Agricultural Adjustment Administration, 1936. Current breakings of frozen eggs for particular firms are reported monthly by the Market News Service, Dairy and Poultry Products Division, Bureau of Agricultural Economics.

TABLE 27.—*Classification of cold-storage holdings of frozen eggs*—Continued

PERCENT THAT ALBUMEN IS OF THE TOTAL

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	July	Aug.	Sept.	Oct.	Nov.	Dec.
1925	24	24	24	25	24	26	24	23	15	23	24	23
1926	24	25	26	26	28	27	26	24	30	25	25	26
1927	27	30	31	35	31	30	30	31	31	32	34	37
1928	40	44	48	42	35	31	29	28	27	27	26	28
1929	30	32	36	39	33	28	25	23	22	22	21	21
1930	20	20	19	20	20	21	20	19	18	18	17	17
1931	17	15	14	16	18	20	20	20	20	20	19	19
1932	19	19	19	19	21	25	28	29	29	30	29	31
1933	32	34	36	35	36	34	32	31	30	28	28	28
1934	28	25	25	24	28	29	29	26	26	25	25	24
1935	22	22	20	21	27	30	30	29	28	28	28	28
1936	27	27	27	26	29	29	30	29	29	28	28	28
1937	29	29	28	27	30	31	30	30	28	28	29	28

PERCENT THAT YOLK IS OF THE TOTAL

1925	29	29	32	28	26	27	26	26	28	25	26	26
1926	28	28	28	29	27	25	23	20	25	19	18	19
1927	20	18	17	20	19	20	20	20	20	19	19	18
1928	18	16	15	14	16	17	17	16	16	16	16	16
1929	16	16	15	17	20	20	18	18	18	18	18	19
1930	20	21	22	22	22	21	21	20	20	20	20	21
1931	20	22	21	20	21	22	22	21	20	21	20	20
1932	20	19	20	17	18	19	20	19	19	18	18	18
1933	18	17	16	17	22	22	22	21	21	23	24	22
1934	23	23	22	24	27	27	26	25	25	25	28	29
1935	31	32	36	38	33	30	27	25	25	25	25	26
1936	26	25	24	23	25	26	27	25	24	25	25	25
1937	26	24	24	25	24	25	26	25	25	25	24	25

U. S. Department of Agriculture Statistical Bulletin No. 48 and monthly cold-storage reports of the Department.

INTERRELATIONSHIP BETWEEN PRICES OF VARIOUS EGG PRODUCTS

In the case of both frozen and dried eggs, whole egg does not represent more than half of the production of these products, the remainder being albumen and yolk separately. There are, therefore, at least seven distinct egg products; namely, shell eggs, frozen whole egg, dried whole egg, frozen albumen, dried albumen, frozen yolk, and dried yolk. There are also variations in the frozen products, such as sugared yolk, salted yolk, and glycerine yolk. In the case of dried eggs some of these products are also sold in sweetened or salted form, and in some cases other food products are added in order to obtain a particular type of product or a lower cost of production. There are also other variations in dried-egg products depending on the method by which the products are produced, such as flake whole egg, spray whole egg, crystal albumen, and powdered albumen.

In the production and marketing of all of these egg products there are involved complex problems of price relationships. Egg breakers and driers operate on different bases, and some will be more interested in yolk prices than in albumen prices while others will be more interested in the price of albumen. There is no constant relationship between the value of albumen and the value of yolk, and prices of one or the other may fluctuate materially without regard to fluctuations in the price of frozen whole egg or of shell eggs.

Since no published figures are available on prices of frozen eggs, an attempt was made in the course of this study to develop a price series on frozen-egg products. Table 28, which is divided into three parts, shows the monthly prices from 1926 through May 1937 ob-

tained for frozen whole egg, albumen, and yolk as reported by a number of firms doing a considerable amount of egg breaking. While these prices will not necessarily be representative of all frozen eggs sold, the firms from which they were obtained do a large business and it might be expected that in general prices obtained by other firms would be somewhat similar. They are simple average prices and are therefore subject to some discrepancy due to the volume of business done at a particular price. It is not unusual for breakers to make contracts with buyers for the quantity of egg products which will be needed during the ensuing year on the basis of prices paid for shell eggs and of operating costs during the spring months, March through June, when the eggs are broken. Carrying charges of approximately one-fourth cent a month per pound are added from August 1 through to the following spring.

Ratios have been constructed from these prices which show the value of frozen yolk in relation to frozen whole egg and the value of frozen albumen in relation to frozen whole egg during the production period from March through June. These ratios are shown in table 29.

TABLE 28.—*Wholesale prices per pound of frozen-egg products*[1]

FROZEN WHOLE EGGS

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Yearly average
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1926	26.2	25.6	24.8	26.1	26.6	26.8	27.0	27.0	27.0	27.0	27.0	27.2	26.5
1927	27.5	26.8	25.1	24.0	23.1	22.2	22.1	22.2	22.2	22.4	22.5	22.8	23.6
1928	23.0	22.3	23.9	25.2	26.0	26.1	26.5	26.5	26.5	26.5	26.5	25.7	25.4
1929	24.7	24.7	24.9	24.8	25.7	26.2	26.2	26.3	26.8	27.1	27.4	27.4	26.0
1930	27.8	27.5	26.5	24.6	22.8	22.5	22.5	22.4	22.7	22.4	22.3	21.8	23.8
1931	21.3	20.3	18.7	18.1	15.5	16.0	15.7	15.9	16.3	16.4	16.3	16.2	17.2
1932	15.6	15.2	13.8	11.4	11.3	11.5	11.7	11.9	12.1	12.8	13.0	13.4	12.8
1933	13.6	13.1	12.7	12.0	12.1	11.8	12.1	12.3	12.2	12.1	12.1	12.2	12.4
1934	12.5	12.7	13.4	14.0	14.3	14.4	14.5	14.9	15.0	15.1	15.2	15.2	14.3
1935	15.6	16.3	17.0	18.4	20.0	20.3	20.3	20.3	20.5	20.3	20.0	19.6	19.0
1936	18.8	18.1	17.7	17.2	17.2	17.4	17.8	18.4	18.4	18.5	18.9	19.4	18.2
1937	20.0	19.9	19.9	19.9	18.4	------	------	------	------	------	------	------	--------

FROZEN ALBUMEN

1926	26.2	24.8	23.2	24.0	24.2	24.1	24.0	24.1	24.0	24.0	24.0	24.0	24.2
1927	24.0	23.2	21.2	19.2	18.6	17.4	17.0	17.0	16.0	14.8	13.8	13.5	18.0
1928	13.5	12.8	12.5	13.0	13.8	13.5	13.5	13.5	12.4	12.2	12.5	12.0	12.9
1929	11.3	10.5	10.0	10.1	12.6	14.9	15.5	15.8	16.9	17.8	18.6	19.0	14.4
1930	18.0	17.8	17.3	15.0	14.6	15.0	15.0	15.3	16.0	16.0	16.3	16.5	16.1
1931	16.3	15.7	14.0	13.7	12.9	13.5	13.4	13.6	13.6	13.7	13.5	13.6	14.0
1932	12.9	12.4	11.6	10.1	8.9	9.0	9.2	9.0	9.1	9.0	10.0	10.1	10.1
1933	10.0	8.8	7.4	6.5	6.8	7.0	7.5	7.8	8.0	8.1	8.5	8.3	7.9
1934	8.2	8.7	8.9	9.2	9.4	9.5	9.7	9.9	10.0	10.0	10.3	10.3	9.5
1935	10.8	11.4	12.2	13.3	14.5	14.3	14.6	15.1	15.3	15.2	14.8	14.3	13.8
1936	13.5	13.0	12.2	11.4	11.5	11.5	11.7	12.1	12.2	12.4	12.8	13.4	12.3
1937	13.5	13.3	13.0	13.0	12.1	------	------	------	------	------	------	------	--------

FROZEN YOLK

1926	27.0	26.2	24.8	27.2	28.8	29.4	30.3	30.6	30.8	30.8	30.8	30.8	29.0
1927	30.8	30.6	30.5	30.2	30.4	30.5	30.5	30.8	31.2	32.2	32.8	33.2	31.1
1928	33.8	34.0	35.4	37.5	38.0	38.7	40.2	41.0	41.0	40.0	39.5	38.0	38.1
1929	36.7	38.0	39.0	39.0	40.4	40.4	40.4	40.4	39.9	39.6	39.4	39.4	39.4
1930	40.3	39.2	36.9	32.4	31.6	31.6	30.8	29.8	30.9	30.8	30.6	29.7	32.9
1931	29.0	27.6	26.5	23.5	19.7	20.3	20.4	21.0	21.0	21.2	21.1	21.2	22.7
1932	20.7	20.0	17.9	17.6	16.4	15.1	15.6	17.3	17.2	17.7	19.8	18.6	17.8
1933	18.6	18.2	18.1	18.6	19.2	19.5	19.7	19.8	19.6	19.7	19.8	20.0	19.2
1934	19.9	20.1	21.3	20.3	20.2	20.4	20.7	20.9	20.8	21.3	21.6	21.3	20.7
1935	21.6	22.2	23.0	24.7	26.5	26.3	27.1	26.4	26.4	26.2	26.2	26.1	25.2
1936	25.4	24.8	22.7	22.2	22.8	24.7	25.1	25.5	25.8	25.8	26.6	26.9	24.9
1937	27.1	27.2	27.3	27.4	25.2	------	------	------	------	------	------	------	--------

[1] Average of prices reported by 4 large domestic producers.

TABLE 29.—*Frozen-yolk prices and frozen-albumen prices as percentages of frozen whole-egg prices, March-June 1926–37*

Year	Percent yolk price is of whole-egg price	Percent albumen price is of whole-egg price	Year	Percent yolk price is of whole-egg price	Percent albumen price is of whole-egg price
1926	105.7	91.6	1932	140.0	82.5
1927	128.8	80.9	1933	154.1	56.6
1928	147.8	52.2	1934	147.1	65.7
1929	156.3	46.9	1935	132.8	72.0
1930	137.3	64.3	1936	132.8	66.7
1931	131.6	78.9	1937 [1]	137.1	65.5

[1] March-May.

This table shows that while the ratio of yolk value to whole egg value has varied from 105.6 to 156.3, with the exception of the year 1926 there has been relatively little fluctuation in this ratio as compared to the ratio of albumen value to whole egg value,[34] which has varied from 46.9 to 91.7. It will be noticed that the two ratios show an inverse correlation, when one is high the other is low, and vice versa. The two ratios together usually add up to approximately 200, as they naturally would since, if necessary, frozen whole egg could be reconstituted from yolk and albumen. However, from 1931 through 1934 the two ratios together equalled substantially more than 200.

The value of frozen yolk per pound is always considerably more than the value of albumen per pound; usually yolk is about twice as expensive as albumen although in 1926 albumen prices more nearly approached yolk prices than they have in any later year. Approximately 55 percent, by weight, of an egg is albumen, but this does not bear any relationship to its relative value. This is true partially because the uses for frozen albumen are more limited than the uses for yolk and partially because albumen consists of about 89 percent water while yolk consists of only 56 percent water.

Figure 13 is a line chart showing roughly the relationship which has existed during the period from 1926 through 1936 between changes in the United States farm price of shell eggs during March through June and annual changes in prices of whole egg, albumen, and yolk in frozen form. It is readily apparent from this chart that the price of whole egg generally varies in a similar way with changes in the price of shell eggs. This is not always true in the case of yolk and albumen. However, as would be expected, when yolk prices are high in relation to prices of shell eggs, albumen prices are generally low, and vice versa. Prices of frozen albumen and yolk together generally fluctuate in close agreement with prices of shell eggs.

Prices of imported dried-egg products are presented under the section of this study dealing with international trade in dried eggs. Monthly prices of dried whole egg, albumen, and yolk, as obtained from the Oil, Paint, and Drug Reporter, have been used in studying the relationship which has existed during past years between changes in the price of frozen eggs and changes in price of dried eggs. Mem-

[34] The coefficient of variation in the series of yolk ratios is 9.5 while in the series of albumen ratios it is 18.4.

bers of the trade state that these prices in general reflect prices at which actual sales are made, and although they are usually some-

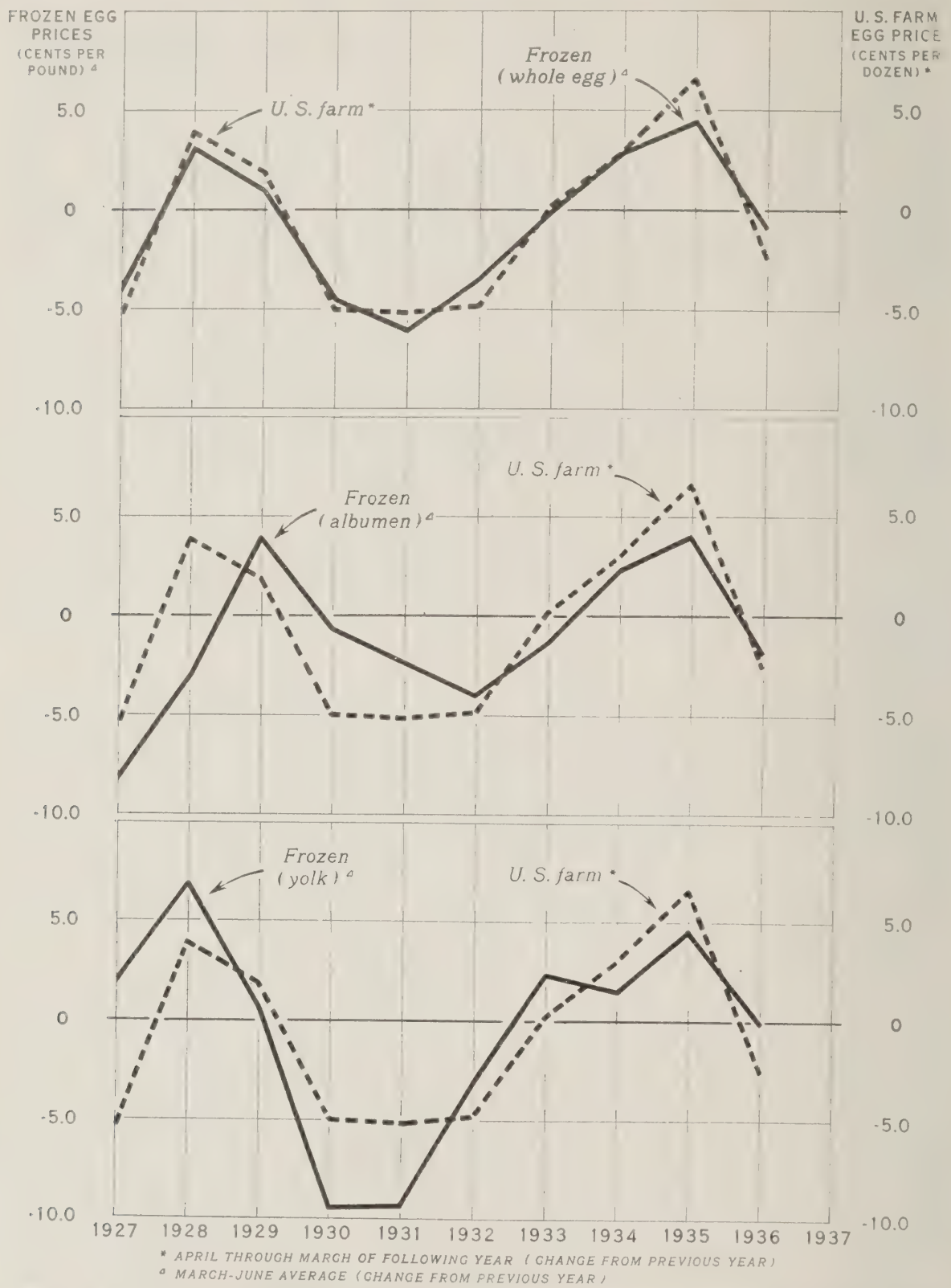

FIGURE 13.—United States farm shell-egg prices and prices of frozen whole egg, albumen, and yolk, 1926–36. The price of frozen whole egg varies quite uniformly with farm prices of shell eggs. Prices of frozen yolk and albumen do not vary so uniformly because, when yolk prices are high in relation to shell eggs, albumen prices are low, and vice versa. See table VI in Appendix A.

what higher than prices at which the bulk of sales are made, changes which have taken place from one period to another probably reflect accurately the actual change.

Figure 14 shows the relationship which has existed during past years between changes in prices of imported dried albumen and

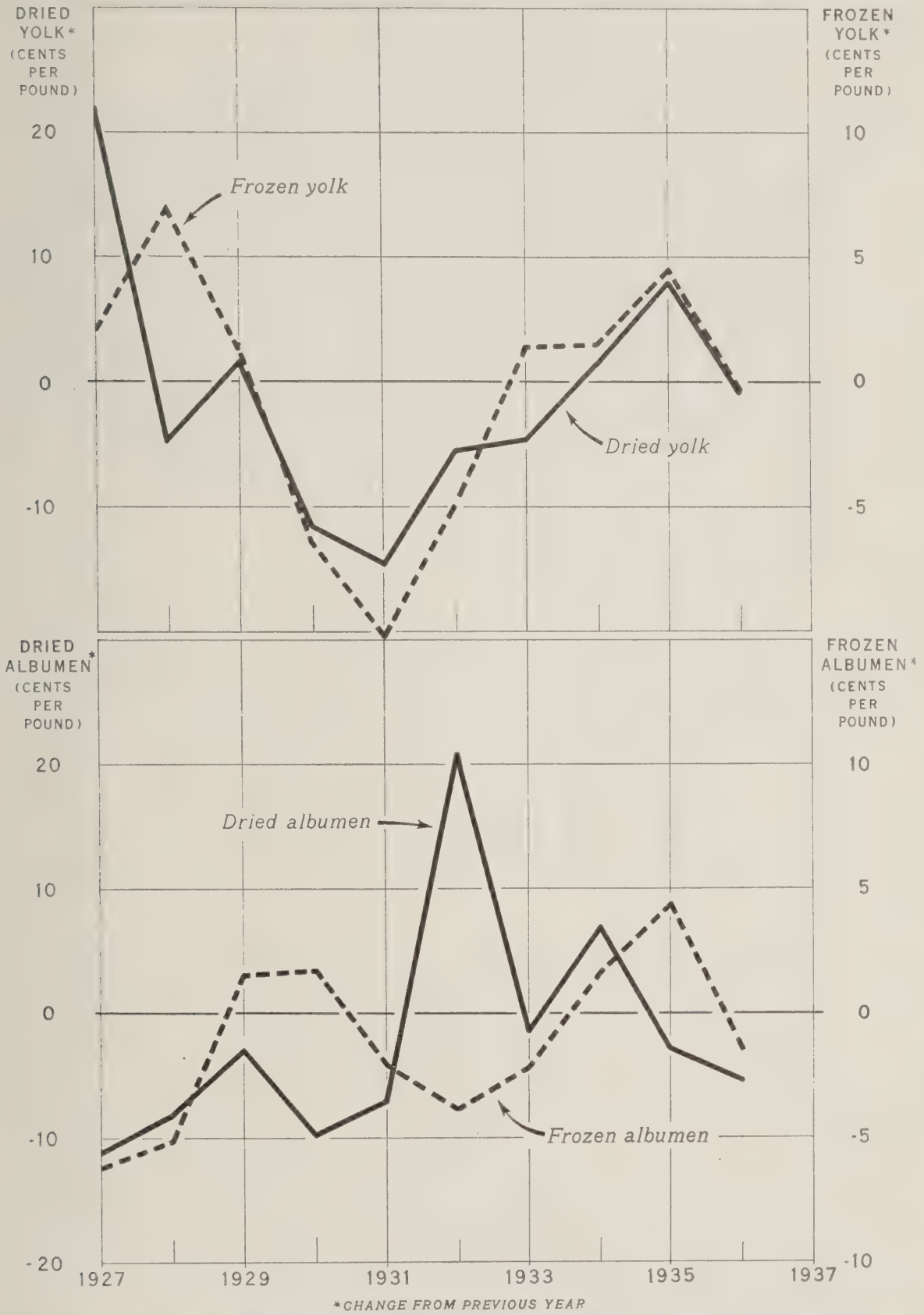

FIGURE 14.—Annual prices of domestically produced frozen yolk and albumen, and annual prices of imported dried yolk and albumen, 1926–36. The prices of dried and frozen yolk have generally varied quite closely except for the years 1927 and 1928 when civil-war conditions in China caused a large increase in dried-yolk prices. Prices for frozen and dried albumen have not varied together, and changes in prices of dried albumen appear to have had no relation to changes in prices of dried yolk.

changes in prices of domestically produced frozen albumen, and this same relationship between imported dried-yolk prices and domes-

tically produced frozen-yolk prices. Changes in prices of dried yolk have usually followed quite closely changes in prices of frozen yolk, except for the years 1927 and 1928. In 1927 the price of imported dried yolk reached very high levels because of civil-war conditions in China. There was naturally a decline from this high level in 1928, although during the same period prices of domestically produced frozen yolk were advancing. Changes in prices of dried albumen show little relationship to changes in prices of the frozen product. This is at least partially due to the fact that frozen albumen cannot be substituted for dried albumen as readily as frozen yolk can be substituted for dried yolk. There is a fairly consistent demand, from year to year, for a small quantity of dried albumen for which liquid albumen cannot be substituted.

The two solid lines in figure 14, which represent changes in the prices of dried yolk and albumen, also indicate that prices of these two products have not shown corresponding fluctuations since 1927 and therefore are influenced by different factors of supply and demand.

EFFECT OF CHANGES IN EGG SUPPLIES ON EGG PRICES

In discussions regarding dried and frozen eggs the question is continually raised as to the effect that the egg-freezing and egg-drying industries have had on producers of shell eggs. Whenever consideration is given to tariff proposals, proposals for benefit payments, or to the question of these industries in themselves, an attempt is invariably made to show that the development of the domestic industry has an effect, either beneficial or detrimental, on domestic egg producers. This involves the whole problem of the effect of changes in supply on changes in the price of eggs. Analyses have been made, therefore, of the relationship which has existed in past years between changes in the supply of eggs and changes in the price of eggs after allowing for other factors which may have affected price changes.

The large bulk of frozen and dried eggs is produced in the Middle Western States from Texas to Minnesota, where egg prices reach the lowest levels because of a large surplus production during spring months. Figure 15 shows the average farm egg price by States in cents per dozen, during March, April, May, and June for the 5-year period 1932 through 1936. At the present time the bulk of domestically dried eggs is produced in the States of Texas, Oklahoma, Kansas, and Missouri. In these States, because of a large spring supply of eggs, egg prices average lowest in the spring of the year. In some of the Northwestern and Southeastern States egg prices are also relatively low, but in these cases the available supply of eggs is limited. Figure 16 shows the relationship which has existed between changes in the average farm price of eggs in Kansas, Texas, Oklahoma, and Missouri, and the United States average farm price during March–June, from 1910 through 1936. This chart shows that, with only slight variation, changes in the sectional price of eggs have been accompanied by similar changes in the United States price. Further analysis between egg supplies will be limited, therefore, to the United States farm price of eggs.

The effect of removing a particular quantity of eggs from the normal channels of trade would not necessarily be the same under vary-

ing conditions. For instance, it is possible that a change in supply of eggs brought about quickly and by artificial means might have more effect on prices, at least in the short run, than a change occur-

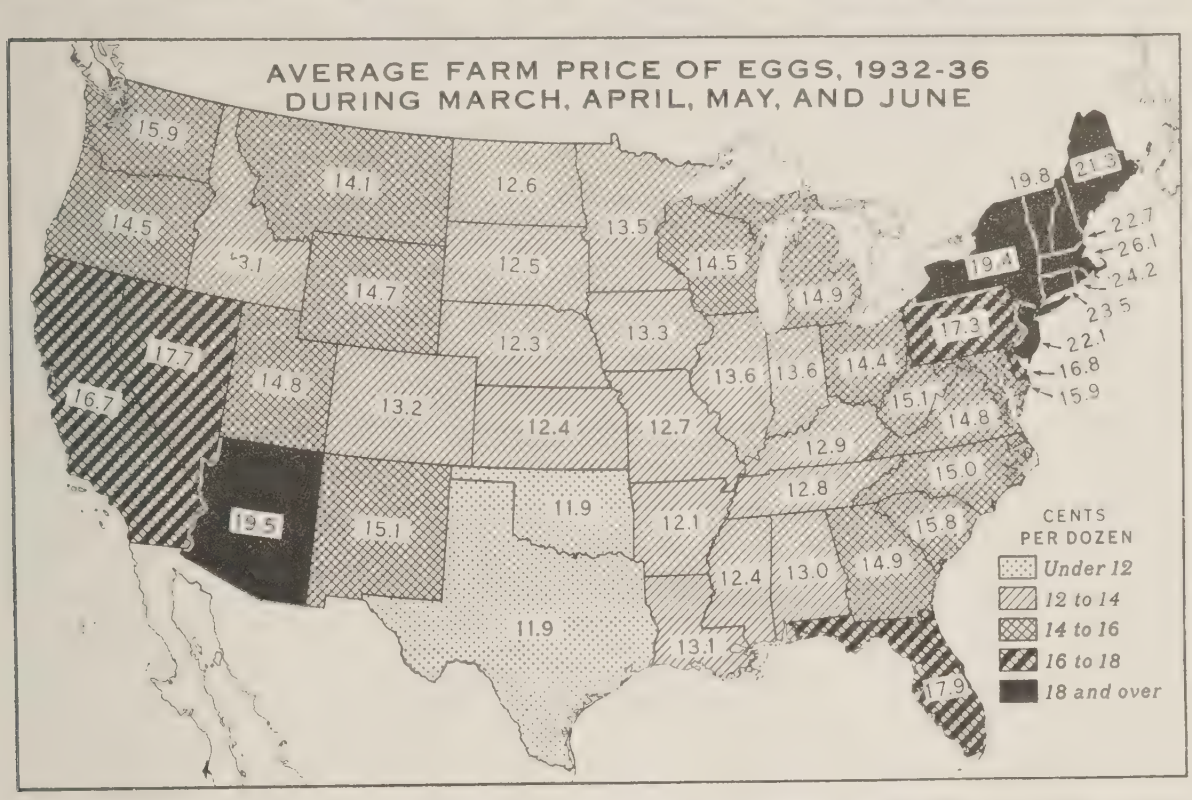

FIGURE 15.—The States of Texas, Oklahoma, Kansas, and Missouri have the lowest average farm price of eggs as well as an abundant supply of eggs during the egg-drying season. These are the States which produce most of our dried-egg products.

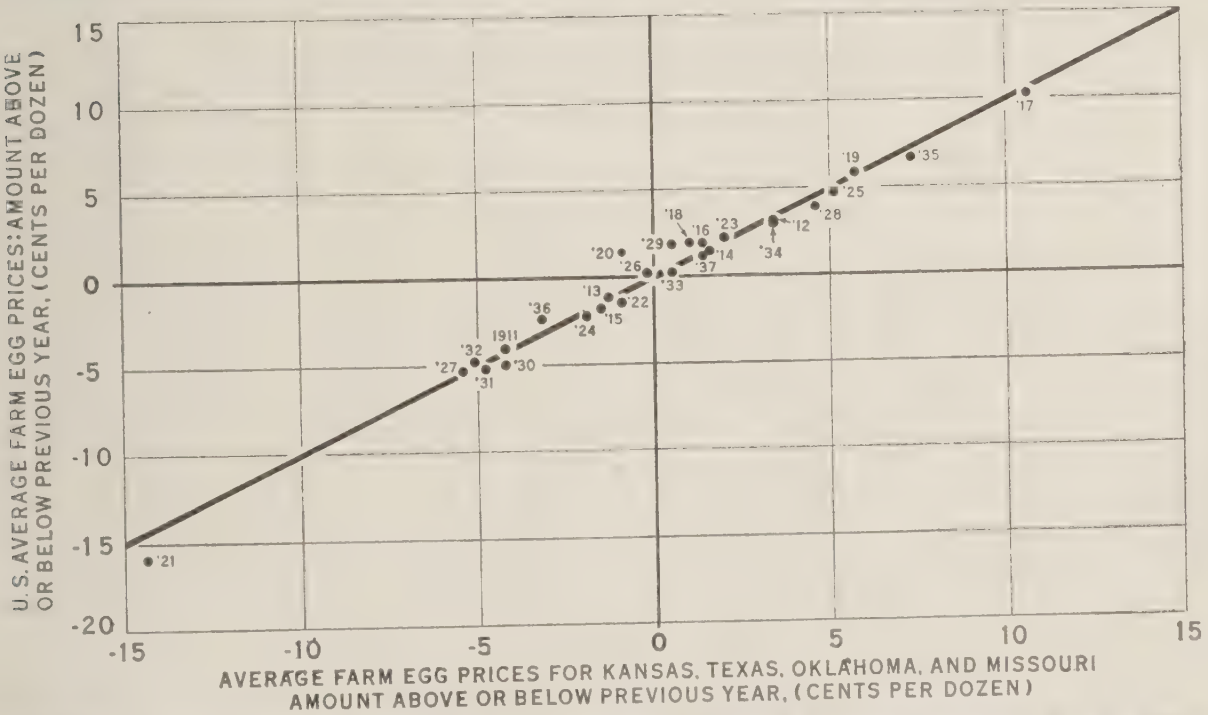

FIGURE 16.—During the spring months the United States average farm price of eggs is directly related to the average farm price in the area where the bulk of dried-egg products is produced. See table VIII in appendix A.

ring from natural conditions. This would be particularly true if the change were accompanied by a great deal of publicity, which would undoubtedly affect the psychology of traders. It is also possible that changes in the supply of eggs might have more effect on egg prices when the supply of competing foods is small rather than

large. It is certainly logical to believe that a change in the supply of eggs would have more effect on egg prices when these prices are at a high level than when they are at a low level.

In the present study an attempt will be made merely to measure the average relationship which has existed during past years between egg supplies and egg prices. No effort will be made to prove that because certain relationships existed in the past they will necessarily continue to exist in the future.

No satisfactory data dealing with the marketing of eggs, which might be considered to be the supply of eggs available for consumption aside from farm use, are available for a long period of time or for different periods of the year. It has, therefore, been necessary to assume that changes in egg receipts at the four principal markets (New York, Chicago, Philadelphia, and Boston) have corresponded with changes in the supply of fresh eggs marketed. While changes in receipts are not a satisfactory measure of changes in fresh-egg supplies, their use might be justified on the basis that it is the measure the trade sees and uses in determining prices. The available supply of eggs during any particular time of the year is measured not only by the supply of fresh eggs, but also by the quantity of eggs in cold storage. These eggs which are held in storage at different periods of the year represent a considerable proportion of the eggs available for sale during fall and winter months, and they appear to have very important influences on egg prices during the period when the supply of fresh eggs is small.

A change in the available supply of eggs in the spring of the year will influence egg prices throughout the year. The Bureau of Agricultural Economics [35] reports a normal seasonal variation in the production of eggs, as shown in table 30.

TABLE 30.—*Normal monthly variations in the annual production of eggs*

Month	Percentages	
	Monthly	Quarterly
January	6.16	
February	8.17	27.02
March	12.69	
April	13.64	
May	12.81	36.79
June	10.34	
July	8.72	
August	7.41	22.17
September	6.04	
October	5.01	
November	4.27	14.02
December	4.74	
Total	100.00	100.00

From table 30 it is obvious that a portion of the eggs produced during March through June must be carried over for consumption during September through January, since during the 4 spring months more than twice as many eggs are produced per month as during the five fall and winter months. The number of eggs which will be placed in storage during the spring months to be used in fall and winter months depends at least partially upon the production

[35] A Feed-Egg Ratio Expressed in Terms of Eggs [mimeo.] Gordon W. Sprague, Division of Dairy and Poultry Products, Bureau of Agricultural Economics, 1934, p. 5.

of fresh eggs during this early period. Figure 17 shows the relationship between changes in egg receipts during the first 7 months

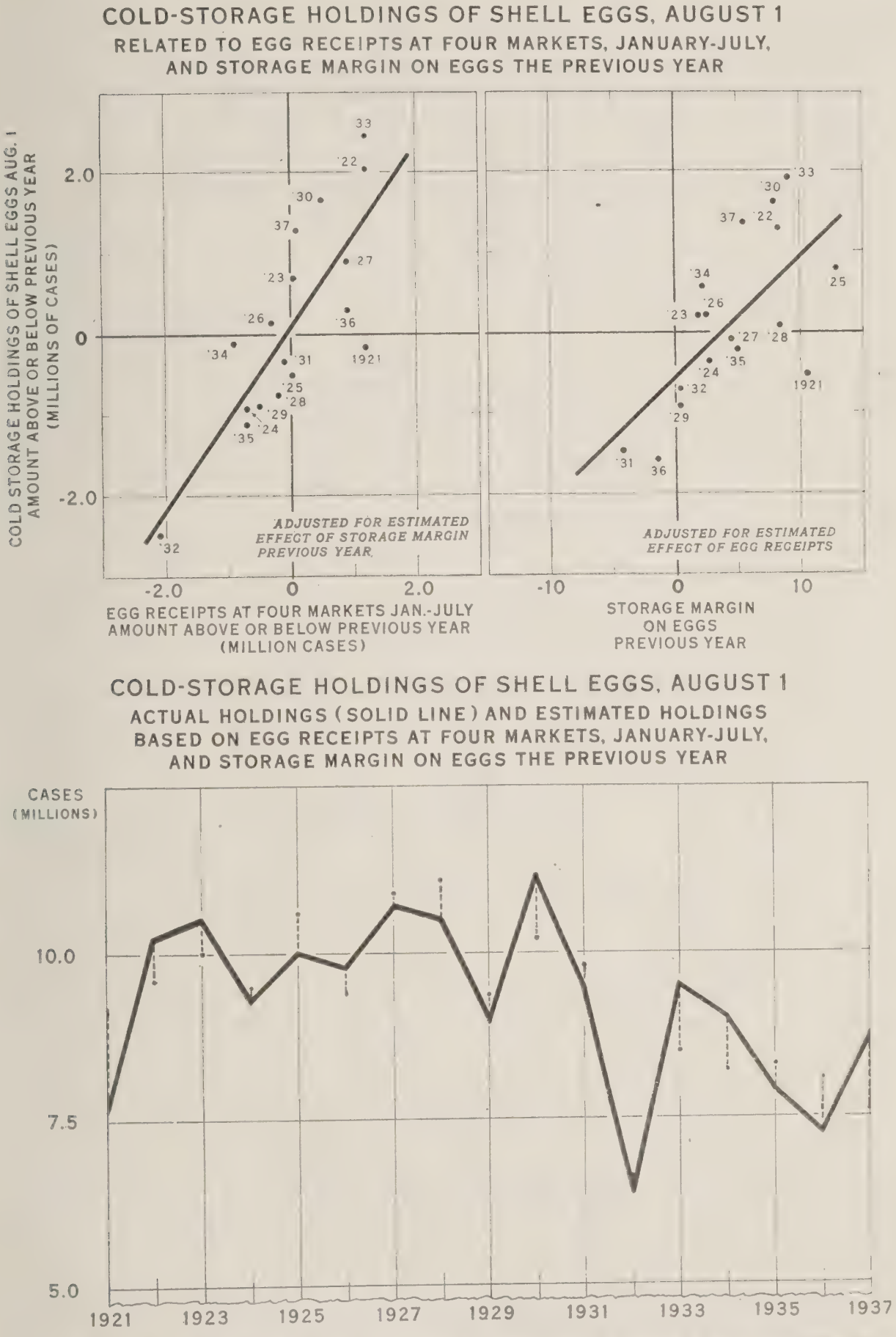

FIGURE 17.—A change of 2 million cases in receipts of eggs at four markets during the first half of the year is usually followed by a change of a little more than 2 million cases in storage holdings of shell eggs on August 1 after allowance for profits from storage operations the previous year. See table IX in appendix A.

of the year and changes in cold-storage holdings of shell eggs after allowing for the effects of profits from storage operations the pre-

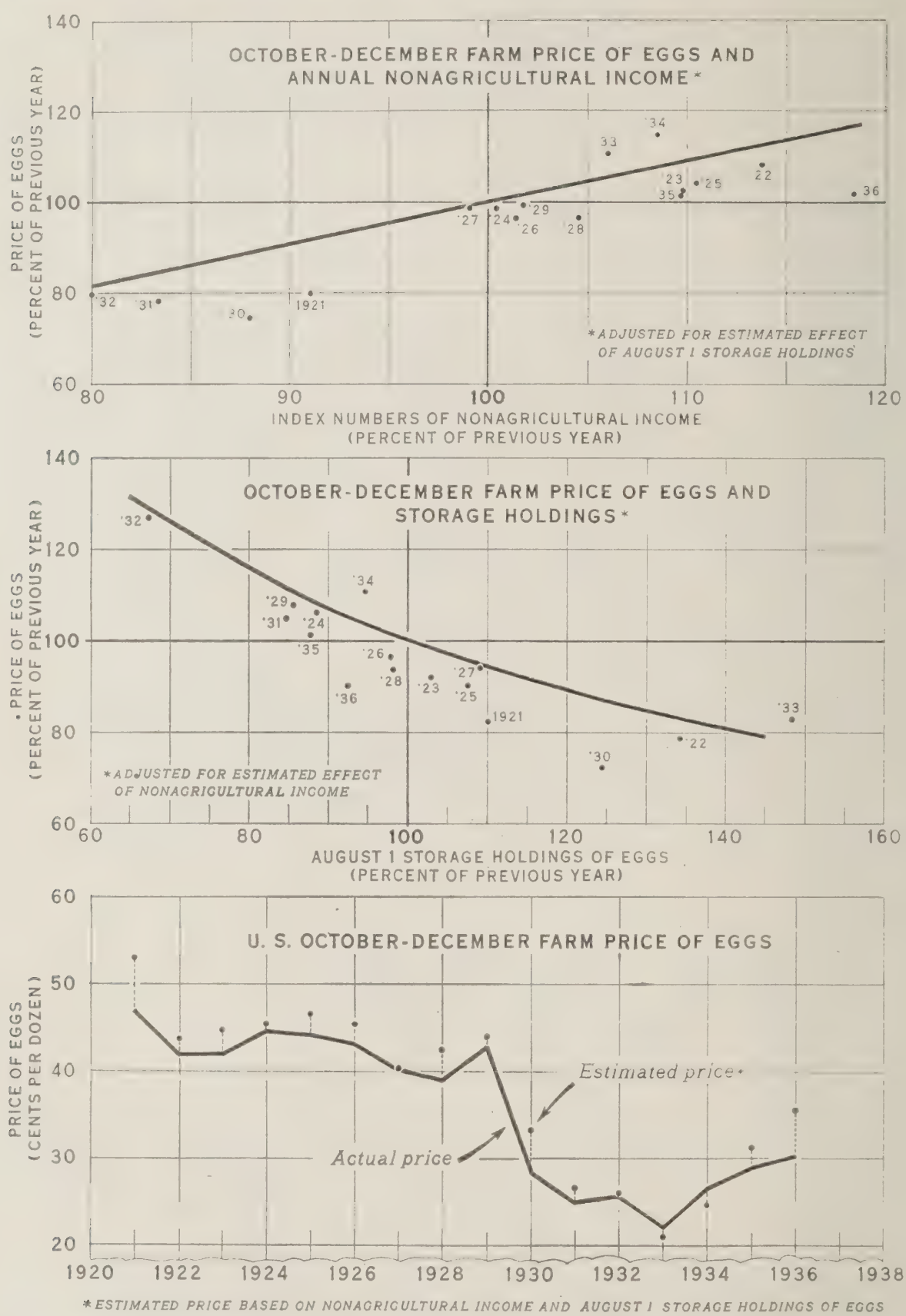

FIGURE 18.—October–December farm price of eggs as influenced by nonagricultural income and cold-storage holdings of shell eggs, 1921–36. The number of eggs in cold storage on August 1 has an important effect on the farm price of eggs during the latter part of the year. See table X in appendix A.

vious year. This chart shows that an increase in egg receipts of 2 million cases has corresponded, during the period from 1921 through

1936, approximately with an increase of 2 million cases in cold-storage holdings of shell eggs as of August 1, and a decrease in egg receipts has corresponded with a similar decrease in storage holdings. Changes in these storage holdings in turn appear to have had an important influence on changes in egg prices during fall and winter months; when, in past years storage holdings have increased prices have decreased, and vice versa, as shown in figure 18. Therefore, if a portion of the supply of fresh eggs is removed from normal trade during the spring period of flush production, it should affect prices to some extent not only immediately, but also indirectly throughout the year. For this reason, in studying the effect that a removal of a certain quantity of eggs might have on egg prices and producers' incomes, annual egg supplies and annual egg prices will be used even though the actual reduction in supplies might occur only during the spring.

Figure 19 shows the relationship which has existed from 1920 through 1936 between changes in the average annual farm price of eggs and changes in three independent variables: (1) Annual egg receipts at four markets, (2) average annual index numbers of non-agricultural income, and (3) cold-storage holdings of shell plus frozen eggs (in case equivalents) on the first day of the year. This relationship has been determined on the basis of percentage changes in these factors from one year to the next. It has been assumed that if there were no change in the independent variables there could be no resulting change in the dependent variable.[36]

On the basis of the relationship shown in figure 19 it is possible to determine how, during past years, changes in the annual supply of eggs have been related to changes in annual farm egg prices. This relationship indicates that a decrease of 2 percent in the supply of eggs has been related to an increase of 2.5 percent in the price of eggs during the same year. There would also be some additional, although indirect, influence on egg prices the following year since the number of eggs in cold storage on January 1 also affects the price of eggs.

It has already been shown that the peak imports of dried eggs were somewhat less than 2 percent of the total supply of eggs used during any one year. If, therefore, the total supply of eggs were reduced by this amount, by withholding the imports of dried-egg products into this country the price of eggs might be increased approximately 2.5 percent. Farm egg prices during recent years have averaged approximately 26 cents per dozen. If egg prices were at 26 cents per dozen they might, therefore, be increased to 26.65 cents per dozen or an increase of about 0.65 cent by reducing the supply 2 percent.[37] If the total supply of eggs sold from farms were 2 billion dozens, an increase in the price of eggs of 0.65 cent per dozen would result in an increased value of these eggs to producers amounting to 13 million dollars. It can, therefore, be stated that, on the

[36] In each instance the regression line has been drawn so that it passes through 100 percent (zero change) in the independent variable at the 100 percent point (zero change) in the dependent variable even though such a line might not fit the dots in the scatter diagrams as closely as some higher or lower line. The line of best fit, assuming both means to be zero, has been determined by the least squares method.

[37] If the farm price of eggs were higher than 26 cents the increase in actual cents per dozen would be somewhat more than 0.65 cent, and if prices were lower the increase would amount to less in terms of actual cents. It would, for instance, on the basis of this relationship, require egg prices to be at 40 cents a dozen in order to obtain a 1-cent-per-dozen increase in prices by reducing the supply 2 percent.

basis of the relationship shown in figure 19, if no imports of dried eggs were permitted to enter this country in a particular year and

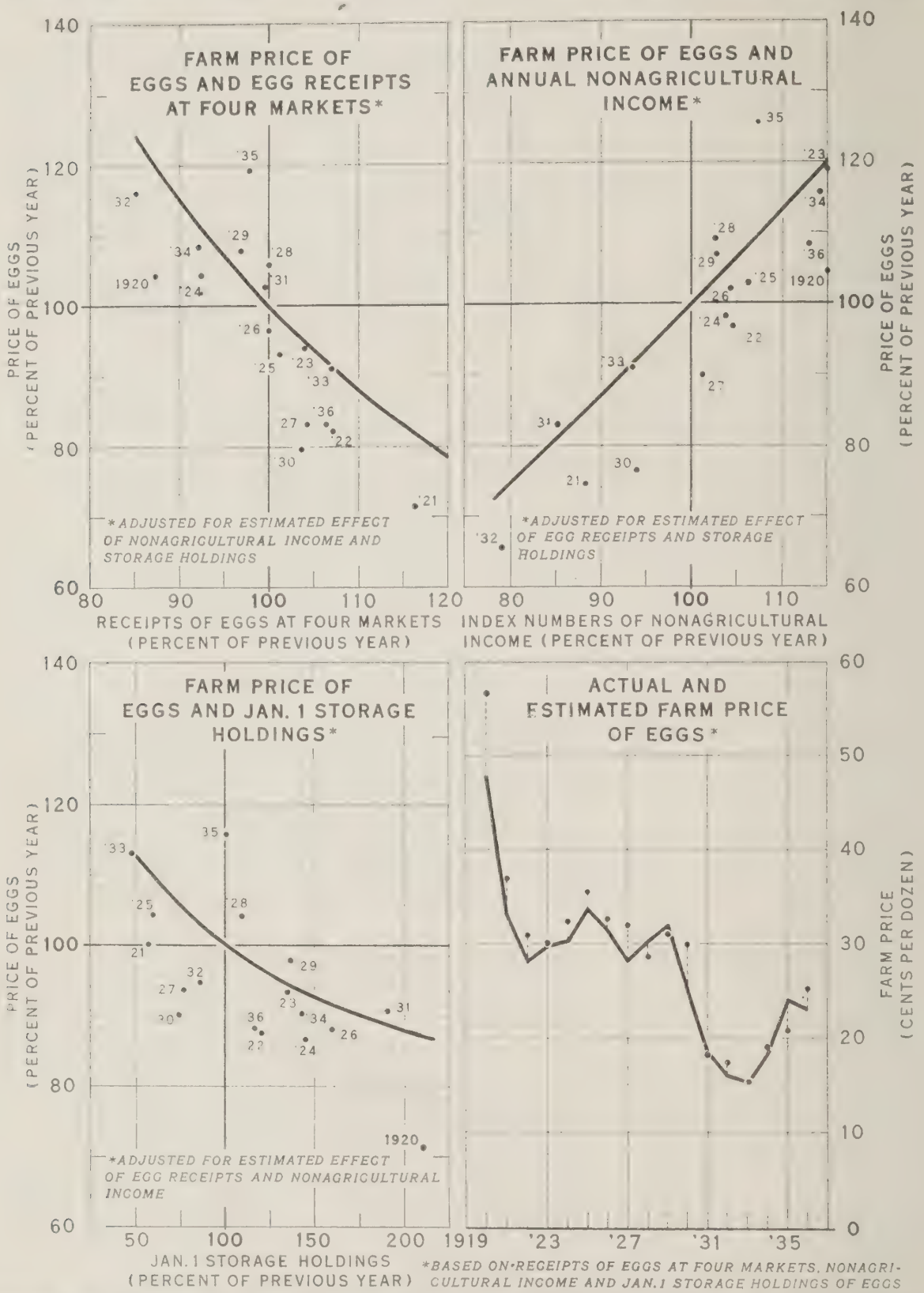

FIGURE 19.—Average annual farm price of eggs as influenced by egg receipts, nonagricultural income, and cold-storage holdings of shell and frozen eggs on January 1, 1920–36. The supply of eggs, as measured by egg receipts, is important in determining the average annual farm price of eggs. See table XI in appendix A.

a decrease of 2 percent in the total supply of eggs resulted therefrom, the total value of the egg crop sold by producers during that year might be increased by about 13 million dollars, if egg prices were at the level of 26 cents per dozen.

Table 31 shows the hypothetical levels of income from egg sales based on percentage changes from a 2-billion dozen egg supply, provided these changes would result in increases or decreases from the level of 26 cents per dozen in the farm price of eggs as indicated by the relationship shown in figure 19. From this table it can be seen that as the percentage of decrease in the supply of eggs becomes larger the resulting increases in producers' incomes become larger, and that as the percentage of increase in the supply of eggs becomes larger the decreases in the resulting producers' incomes become smaller.

TABLE 31.—*Hypothetical levels of income derived from various levels of egg sales, computed in terms of percentage changes from an assumed base of a 2 billion dozen egg supply and an average price of 26 cents per dozen*

[Based on figure 19]

Supply of eggs		Price of eggs		Income from egg sales	
Percentage change in supply levels	Supply based on percentage change from 2-billion dozen supply	Percentage change in price levels	Farm price based on percentage change from 26 cents	Resulting income from egg sales. (Price × supply)	Increase or decrease in income from 520-million dollar level
Percent	*Billion dozens*	*Percent*	*Cents per dozen*	*Million dollars*	*Million dollars*
80	1.6	134.4	34.944	559.1	39.1
85	1.7	124.1	32.266	548.5	28.5
90	1.8	115.0	29.900	538.2	18.2
95	1.9	107.1	27.846	529.1	9.1
100	2.0	100.0	26.000	520.0	0
105	2.1	93.7	24.362	511.6	−8.4
110	2.2	88.1	22.906	503.9	−16.1
115	2.3	83.1	21.606	496.9	−23.1
120	2.4	78.5	20.410	489.8	−30.2

USES OF DRIED-EGG PRODUCTS

Reference to table 2, which gives the shell-egg equivalent of the total available supplies of both imported and domestically produced dried-egg products, shows that no permanent expansion has occurred in the industry since 1920. The volume of supplies used during 1921 to 1925 was approximately the same as during 1937, when this country had substantially recovered from the depression. Since 1920 the population of this country has increased approximately 21.5 percent, so that although the physical annual volume of our dried-egg supplies has not been reduced the per capita supply at the present time is considerably less than formerly.

Among the many reasons that may be responsible for this condition, only two need be mentioned here. The first and least important is the better facilities for refrigerating and holding eggs by relatively small bakers, and the fact that daily delivery of frozen eggs in small cans is now being practiced. The second reason is the tremendous growth of the egg-freezing industry. Information concerning the growth of this industry is available at the present time only on the basis of the amount of frozen-egg products placed in cold storage. The following comparison will serve to illustrate the growth in the volume of its production. From 1917 through 1921 the peak storage holdings averaged approximately 23.2 million pounds annually. The 5-year average (1932–36) peak holdings amounted to approximately 112 million pounds. In 1937 the peak

storage holdings on August 1 had advanced to 167 million pounds, the greatest on record since these data were first obtained in 1916. This increase in the use of frozen eggs has occurred at the expense of shell eggs principally, and of dried eggs only to a limited extent.

The volume of dried whole egg consumed is relatively small, and by far the largest part of it is used in bakery products, such as cakes, cookies, muffins, etc.[38] The next most important use is probably in the manufacture of prepared flours, such as cake, pancake, doughnut, pie, and pudding mixes, and various food-beverage powders. Other relatively unimportant uses for dried whole egg are in mayonnaise and prepared animal foods, such as dog, bird, and fox foods, and in other commercial animal feeds.

Large quantities of dried albumen are used in the confectionery industry. Dried albumen is preferred by many of the manufacturers to liquid albumen because the process of fermenting before drying improves the whipping qualities. Manufacturers of such articles as chocolate creams, marshmallows, and candy bars use large quantities of dried albumen. Next in importance to the confectioners are the manufacturers of meringues, meringue powders, and icings. It is very important that the albumen used in these products has excellent whipping qualities. Other uses for albumen are in baking powder, some prepared flours, and fish food.

There are several industries, such as the leather industry and the bookbinding and photographic industries, that use or have used albumen in technical processes. Some is used also in preparing textiles, pharmaceuticals, paper, and art paints and colors. The total volume consumed in these technical uses is comparatively small and unimportant since in some fields, such as the tanning of leather, the quality of albumen required is much lower than is needed for foodstuffs. All available information indicates that the outlets for dried albumen in other than the food industries are declining in the face of increasing competition from casein and serum or blood albumen which are available at much lower prices and are reputed by some manufacturers to give even better results.

Dried yolk is the most important dried-egg product. It is used in preparing practically all the food products mentioned as uses for whole egg. The prepared-flour industry has been a particularly large user of dried yolk. In recent years the number of prepared flours of various types has been growing constantly, not only for the retail trade, but for the wholesale trade as well. It is difficult to estimate the quantity of dried yolk used in these flours, but an indication of the volume used can be obtained from the fact that a large manufacturer in a recent year was reputed to have used approximately 1 million pounds of dried yolk in preparing ready-mixed doughnut flours. Large quantities are also used in the several types of pancake, waffle, and cake flour mixes that are prepared for the retail trade.

In view of the findings of the United States Tariff Commission quoted on page 38 and of more recent information obtained from industrial sources, it is believed that in 1936 more than 80 percent of the annual consumption of dried eggs was in the manufacture of products in which frozen or shell eggs could not be used. Many

[38] Production of Frozen Eggs in the United States in 1935. [Mimeo.] Poultry Section, Agricultural Adjustment Administration, 1936.

small bakers and confectioners who used dried eggs as recently as 1931 have since installed refrigerating facilities and are now using frozen eggs. Daily delivery of frozen eggs in small cans is now being made by some companies that sell frozen eggs to small users who are not equipped with refrigerating facilities. Since frozen eggs now appear to have replaced dried eggs in most of the uses where the two types of products are interchangeable, it is believed that the per capita consumption of dried eggs will not continue to decline as it has in the past. If the prepared-flour industry continues to expand, it is believed that the consumption of dried eggs might even show an increase in the future.

Aside from the possible increase in use of prepared flours, it appears that any further expansion of the egg-drying industry must come in either or both of two ways: (1) Through a definite improvement in quality and uniformity of products, and (2) through new uses which may be found and the improvement in merchandising methods that will be required to introduce the new products to the public. Samples of dried yolk, for instance, show wide variations in color, some being pale yellow and others deep orange. Further variations are found in the keeping qualities, the objectionable odors, and in the amount of albumen that is allowed to cling to the yolk when eggs are separated preparatory to drying. Samples of dried albumen also show wide variations in the moisture content, the beating or whipping qualities, and in the amount of siftings or very small particles that do not readily dissolve in water.

Any improvement of the quality and uniformity of the products as well as any improvements in the field of merchandising, such as uniform packaging, will help the egg-drying industry in regaining some of the markets it has lost to the egg-freezing industry and might, to a small extent, increase the total annual consumption of eggs.

The following standards of quality for dried albumen, yolk, and whole egg have been published as follows by the Egg Products Association of America, Inc.

STANDARDS OF QUALITY FOR ALBUMEN

1. Fancy hen (chicken) albumen crystals:
   Appearance: Bright clear crystals.
   Siftings: Not to exceed 20 percent.
   Odor: No objectionable odor.
   Beating: Beat 90 to 100 percent with good consistency, minimum 6¼-inch after leveling.
2. Prime hen (chicken) albumen crystals:
   Appearance: Bright clear crystals.
   Siftings: Not to exceed 20 percent.
   Odor: No objectionable odor.
   Beating: Beat 80 to 100 percent with good consistency, minimum 5¾-inch after leveling.
3. Fair hen (chicken) albumen crystals:
   Appearance: Fairly clear crystals.
   Siftings: Not to exceed 20 percent.
   Odor: Slight odor permissible.
   Beating: Beat 70 to 85 percent with good consistency, minimum 5¼-inch after leveling.
4. Poor hen (chicken) albumen crystals:
   Appearance: Unimportant.
   Siftings: Not to exceed 20 percent.
   Odor: Unimportant.
   Beating: Beat 50 to 70 percent with fair consistency, minimum 4¾-inch after leveling.

5. Nonbeating hen (chicken) albumen crystals:
   Appearance: Unimportant.
   Siftings: Not to exceed 20 percent.
   Odor: Unimportant.
   Beating: No test necessary.
6. Chicken albumen siftings, duck albumen, and duck albumen siftings to be sold under the same description.

STANDARDS OF QUALITY FOR YOLK AND WHOLE EGG

1. Prime spray hen (chicken) egg yolk:
   Taste: Sweet and wholesome.
   Texture: Smooth and velvety.
   Solubility: Good.
   Color: Good bright yellow appearance.
2. No. 2 spray hen (chicken) egg yolk:
   Same requirements as prime except color is not guaranteed.
3. Summer cargo spray hen (chicken) egg yolk:
   Same as No. 2 quality, but "Summer Cargo" must be mentioned.
4. Prime granular hen (chicken) egg yolk:
   Taste: Sweet and wholesome.
   Color: Bright deep yellow, as nearly uniform as possible.
5. No. 2 granular hen (chicken) egg yolk:
   Taste: Sweet and wholesome.
   Color: Not guaranteed.
6. Prime spray whole hen (chicken) egg:
   Taste: Sweet and wholesome.
   Texture: Smooth and velvety.
   Color: Good.
   Albumen: Contents about 33 percent on dry basis.
7. No. 2 spray whole hen (chicken) egg:
   Taste: Sweet and wholesome.
   Texture: Smooth and velvety.
   Color: Not guaranteed.
   Albumen: Contents about 33 percent on dry basis.

NOTE.—The same method of determining the grades is applied to duck yolk, with the exception that the color reads "bright reddish orange."

One possible new use for dried eggs may be found in home consumption, for it is believed that dried whole egg, sold in 1-pound packages, might fill a definite need for the housewife. There are several possible uses for dried yolk and albumen in the home, but the greatest outlet would be for dried whole egg. Table 24 shows that a definite saving can be obtained by using dried whole egg; and it is believed that if this saving could be passed on to the retail purchaser, families in the lower income groups particularly might be encouraged to consume a large quantity of this product. Only to a limited extent would this consumption be at the expense of fresh and storage shell eggs since the consumption of eggs by the low income groups is on a comparatively low level.[39] If the consumption of dried whole egg could be encouraged to the extent that a large quantity of eggs was used in this form, it is believed that any slight reduction in demand for shell eggs that might occur would be more than offset by higher prices paid to egg producers in the spring months for eggs to be dried.

The Bureau of Home Economics [40] cooperated with the Agricultural Adjustment Administration by making comparative cooking

[39] Diets of Families of Wage Earners and Low-Salaried Clerical Workers Living in Industrial Communities in Four Regions of the United States, 1934–37 [mimeo.]. U. S. Department of Agriculture, Bureau of Home Economics, 1938.

[40] Dr. Florence B. King, in charge of the Food Utilization Section of the Bureau of Home Economics, supervised the comparative cooking tests and prepared the report from which much of the material in this section was taken.

tests using dried whole egg and fresh shell eggs. Nine samples of dried whole egg were submitted by six companies representing domestic producers as well as importers of Chinese products. Four of the samples had a slightly stale to a very disagreeable odor while the other five samples had a normal egg odor. Preparatory to being used in the cooking tests, the dried whole egg was reconstituted, i. e. three parts of water were added to one part of dried whole egg. This mixture was allowed to stand tightly covered in a cold place for 2 or 3 hours. (After reconstitution the egg mixture is perishable and should be used at once or kept in a cold place. One cup of the reconstituted egg is equivalent to five medium-sized eggs and may be used in any recipe in which whole eggs are used. One level tablespoon of dried whole egg powder is equivalent to approximately one egg.)

The tests proved to be quite successful in baked or cooked foods, but not so successful in such products as custards, scrambled eggs, or omelets, where the egg is the principal ingredient. No difficulty was encountered in using the dried whole egg in preparing the various foods; the egg was simply mixed with the other ingredients as if a fresh egg were being used.

It is believed that the use of dried whole egg may be expanded because it is relatively limited at the present time. Imports of this product have been quite negligible since 1931. The ease with which dried whole egg may be used for baking purposes in the home as well as in restaurants and other public eating places illustrates the possibilities for marketing this product through retail outlets. To open up this market, an educational and merchandising program would have to be initiated in order to acquaint the consuming public with the savings and benefits to be obtained from the use of dried whole egg, and attractive recipes would have to be publicised, since the general public knows little about the use of this product at the present time.

Of the many problems that must be solved before the retail distribution of dried whole egg would be possible, an important one is that of devising some type of container to be used. The moisture content of dried egg must be kept low throughout the period of its use in order to prevent the formation of fatty acids or rancidity.

This problem is much the same as the one which confronted the manufacturers of dried skim milk when they wished to introduce their product to the retail trade. These manufacturers found that to encourage greater general use of dried skim milk in homes where consumption of milk is limited, moisture-proof cartons or packages would be necessary in order to facilitate the distribution of small quantities to the retail trade. The Department of Agriculture reports some progress in the solution of their problem:

> The laboratories of the Bureau of Dairy Industry have found that bags of bond paper containing a laminated glassine inner liner, or well constructed and waxed paper cartons, will exclude moisture over long periods even in a relatively humid atmosphere and can, therefore, be used in the retailing of this product in small lots. Further research work along this line will undoubtedly result in the disclosure or development of other types of containers that can be used for this purpose and should aid materially in the greater distribution and use of dried skim milk.[41]

[41] Yearbook of Agriculture, 1935, U. S. Department of Agriculture, p. 174.

The problems involved in the merchandising of dried whole egg appear to be quite similar to the ones involved in the merchandising of dried skim milk, and the particular problem of a suitable container should be no exception.

A further important problem confronting the egg-drying industry is that of removing the ever-present burden of excess frozen albumen. In past years the demand for frozen yolk has been so great that the consequent annual production of frozen albumen has been increasing faster than the demand for the albumen would justify. This has brought about a situation wherein it appears that egg breakers have been forced to sell their albumen at any price and then sell their frozen yolk at a sufficiently high price to meet the remaining costs as well as their operating profit. This condition of burdensome albumen stocks is reflected back to the egg producer in the form of lower prices in the spring of the year when practically all the frozen eggs are packed.

The discovery, then, of new uses for albumen, either frozen or dried, will be of aid to all three branches of the domestic egg industry. If dried albumen could be produced at lower costs than present production methods permit, or if a superior product could be produced which would command a higher price than at present, then dried yolk could be sold for less, thereby still further expanding the distribution of these products.

The commercial value of albumen lies in its ability to produce a large volume of foam of a rather tenacious character. The greater the foaming properties of a particular sample of dried albumen the greater is its commercial value. This quality of foaming is not present in fresh albumen because a portion of fresh albumen consists of what is commonly referred to as "thick white" as contrasted to the balance of the albumen called "thin white." It is only the thin portion that is capable of producing large quantities of foam. If, however, the albumen is subjected to a process of ripening or fermentation, certain enzymatic and bacteriological actions occur that change the physical colloidal properties of the thick portion so that all the albumen becomes thin and watery, and it then has excellent foaming values. The purpose of the fermentation process, therefore, is to condition the albumen in such a manner that a large volume of tenacious foam may be obtained.

Very little is known regarding the physical, chemical, and colloidal properties of albumen. It is true that because of the expansion of the domestic egg-drying industry during recent years a considerable amount of research and pioneer investigation was begun, yet a still larger program of research is needed to fully explore and discover the many fundamental properties which will result in the production of a more uniform product of high quality. Reference to the patents listed in appendix C, especially the patents granted during the last 5 years, will show that investigators, both governmental and commercial, are working on this problem.

SUMMARY AND CONCLUSIONS

A summary of some of the most pertinent facts brought out by this study is given below:

1. The history of the egg-drying industry since 1878 has been characterized by the changing importance of domestic production of dried-egg products. The industry had its beginning on a commercial scale in the United States but moved to China with the inception of the World War and higher food prices. In 1927 egg-drying operations were resumed in the United States, but did not reach significant proportions until 1932, after an increase in the tariff and a decrease in shell-egg prices. With the increase in shell-egg prices after 1934, imports of dried eggs increased and domestic production declined. Whether or not there is destined to be a permanent egg-drying industry in this country will depend on the several factors influencing prices and costs in both countries, including restrictions which the United States might place on imported egg products, the level of egg prices received by producers in this country, possible new developments in egg-drying methods, and war conditions in China.

2. The resumption of the use of imported dried-egg products instead of those produced domestically, which began taking place in 1935, is now being accompanied, as it was during and immediately following the World War, by efforts on the part of the egg and poultry industry to place restrictions on the imports of these products. Efforts on the part of industry groups to curtail these imports have taken four forms: (1) Legislation introduced in Congress to provide for excise taxes as well as an increase in the tariff on imported egg products; (2) proposals for benefit payments under section 32 of the Agricultural Adjustment Act which would permit domestic products to compete with imported products; (3) various State laws restricting the use of imported dried eggs; and (4) publicity contending that the domestic product is greatly superior to the imported product with respect to freedom from contamination.

3. While the imports of dried-egg products have never amounted to more than 2 percent of the domestic production of shell eggs, members of the egg and poultry industry have felt that these imports have had an important effect on shell-egg prices because they represent a surplus which has acted as a price depressant. Available statistical information indicates that the supply of imported dried eggs does not have any greater effect on shell-egg prices than does any other equivalent amount of eggs. Imports of dried eggs during past years have not been related to low domestic shell-egg prices, but on the contrary have usually been largest during years of comparatively high prices.

4. If it is assumed that decreasing the supply of imported dried eggs would have the same effect as reducing the supply of eggs in shell form, statistical studies can be used to determine the ap-

proximate effect on producers' prices. According to past relationships, a decrease of 2 percent in the available annual supply of eggs has normally been accompanied by an increase of 2.5 percent in the United States average annual farm price of eggs. It might, therefore, be expected that the price of eggs could be increased 2.5 percent by decreasing the supply of eggs marketed by 2 percent. During the period 1921–36 the United States farm price of eggs averaged 26.1 cents per dozen. An increase in the price of eggs of 2.5 percent would therefore amount to 0.65 cent per dozen. However, a complete embargo on imported egg products would not necessarily result in smaller supplies of egg products, except for a short period of time, since any tendency towards higher prices would be accompanied by increased production of domestic shell eggs. It is also possible that higher prices for dried-egg products might result in some substitution of other products for eggs.

5. Imports of dried-egg products since 1927 have fluctuated rather closely with changes in the spread between the price of shell eggs in Shanghai and the United States average farm-egg price. The domestic production of dried-egg products was large and imports were low during the business depression years primarily because of the extremely low price of shell eggs in this country. Manufacturing and overhead costs on dried-egg products represent less than 10 percent of the cost of the finished product, so that selling prices are determined almost entirely on the basis of the price paid for shell eggs.

6. It is believed that the future of the egg-drying industry in this country depends in part upon the extent to which shell eggs become purchased and sold on a graded basis throughout the marketing channels from producer to consumer. Undoubtedly if eggs were carefully graded so as to reflect consumer demand and were sold accordingly throughout the retail, wholesale, and farm markets there would be a wide range in prices for the different grades. In addition to such benefits as would accrue to producers and consumers by selling eggs on a graded basis, domestic egg driers would undoubtedly find it possible to purchase eggs of good interior quality, but which showed exterior defects, at prices which would enable them to compete more favorably with their foreign competitors. There appears to be a sufficient quantity of such eggs to meet all normal demands for both drying and freezing purposes.

7. There is a considerable difference of opinion regarding the quality of imported dried-egg products. During the early days of egg-drying, both in the United States and China, products of questionable quality were sold. Available evidence indicates that most of the material published, particularly during recent years, to show that egg products imported from China are unfit for human use is not founded on facts. The inspection system as it applies to imported products, including the inspection of plants and of the exported products in China and the inspection here of imported products, is probably more rigid than it is on the products produced in this country.

8. In spite of the increase made in the tariff on dried eggs in 1931, imports of dried yolk and albumen reached predepression levels in 1937. Dried whole egg, however, is still being imported in relatively small quantities, probably due to a shift in the demand for this product.

9. Egg products represent from 2.5 to 4.5 percent of the value of our imports from China. Prior to the increase in the tariff these imports consisted to a considerable extent of frozen eggs, but in recent years they have been mainly dried-egg products. The United States is China's best customer for dried eggs, having received approximately half of its exports of these products in the years prior to 1932, and more recently approximately one-third.

10. There is no need for additional egg-drying plants in this country. The present capacity of these plants is sufficient to produce all the dried-egg products consumed in any year, even if none was imported.

11. Methods of producing dried-egg products, although the basic principles are essentially the same as those used prior to the war, have been improved considerably during recent years. Improvements which have taken place in the process of producing dried albumen, including both the fermentation process before drying and the drying itself, have been particularly significant.

12. Dried-egg products are important primarily because they represent a product which is different from shell or frozen eggs and which serves a need that other types of eggs cannot meet. Most of the present consumption of dried eggs, aside from use in bakery products, is in the form of such products as prepared flours and ice-cream and meringue powders. Since shell eggs contain approximately 75 percent water, there are considerable savings to be obtained in the storing and transporting of eggs in dried form as compared to shell eggs. These savings represent a possible opportunity for growth in the use of dried eggs.

13. Expansion of market outlets for egg albumen appears to be particularly desirable. The demand for frozen albumen is considerably more inelastic than the demand for frozen yolk, and in many years prices of frozen albumen have had to be materially reduced in order for the large supplies of this product, occasioned by an expanding demand for yolk, to be consumed. Frozen albumen is therefore in the nature of a "byproduct" of the production of frozen yolk. Further research resulting in the development of new uses for albumen in any form should result in a reduction in the selling price of both frozen and dried yolk without lowering prices paid for shell eggs. This would benefit the poultry industry by encouraging an increased use on the part of food manufacturers.

14. Dried whole egg can be satisfactorily substituted for shell eggs for use in the home, particularly for baking purposes. Some savings could be made in transportation and storage costs for dried whole egg in comparison to storage shell eggs. If these savings were not absorbed by increased merchandizing costs, and dried whole egg was made available in retail outlets, consumers might purchase the dried product more cheaply than storage shell eggs.

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APPENDIX A

TABLES PRESENTING THE DATA USED IN THE STATISTICAL FIGURES AND CHARTS

TABLE I.—*Domestic production and imports for consumption of dried-egg products, 1921–37*

[Data for Fig. 1]

Year	Total supplies	Domestic production	Year	Total supplies	Domestic production
	Pounds	*Pounds*		*Pounds*	*Pounds*
1921	8,541,193	----------	1930	11,459,678	489,065
1922	9,876,620	----------	1931	10,791,015	552,743
1923	5,873,763	----------	1932	4,309,293	2,284,983
1924	8,552,238	----------	1933	6,231,288	3,712,885
1925	11,261,851	----------	1934	7,097,079	4,373,450
1926	10,494,286	----------	1935	9,430,907	3,000,273
1927	8,012,729	556,027	1936	9,210,920	1,360,362
1928	8,192,495	217,183	1937	11,271,715	2,400,615
1929	11,114,948	202,409			

Data on imports obtained from Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

TABLE II.—*Domestic production and imports for consumption of dried-egg products—percent whole egg, yolk, and albumen is of the total supply, 1921–37*

[Data for fig. 2]

Year	Dried yolk		Dried albumen		Dried whole egg		Total dried egg	
	Pounds	Percent of total	Pounds	Percent of total	Pounds	Percent of total	Pounds	Percent of total
1921	3,897,233	45.6	2,643,113	30.9	2,000,847	23.4	8,541,193	100.0
1922	3,584,131	36.3	3,288,938	33.3	3,003,551	30.4	9,876,620	100.0
1923	1,552,920	26.4	2,725,877	46.4	1,594,966	27.2	5,873,763	100.0
1924	4,015,874	47.0	2,946,826	34.5	1,589,538	18.6	8,552,238	100.0
1925	5,591,185	49.6	3,149,693	28.0	2,520,973	22.4	11,261,851	100.0
1926	5,461,176	52.0	3,457,847	33.0	1,575,263	15.0	10,494,286	100.0
1927	3,604,193	45.0	3,367,939	42.0	1,040,597	13.0	8,012,729	100.0
1928	4,585,696	56.0	2,754,530	33.6	852,269	10.4	8,192,495	100.0
1929	5,654,125	50.9	3,983,436	35.8	1,477,387	13.3	11,114,948	100.0
1930	6,672,847	58.2	3,451,929	30.1	1,334,902	11.7	11,459,678	100.0
1931	6,167,432	57.2	2,482,359	23.0	2,141,224	19.8	10,791,015	100.0
1932	2,595,007	60.2	1,677,528	38.9	36,758	.9	4,309,293	100.0
1933	3,804,456	61.1	2,360,875	37.9	65,957	1.1	6,231,288	100.0
1934	4,988,204	70.3	1,821,606	25.7	287,269	4.0	7,097,079	100.0
1935	6,758,166	71.7	2,009,402	21.3	663,339	7.0	9,430,907	100.0
1936	5,928,233	64.4	2,672,443	29.0	610,244	6.6	9,210,920	100.0
1937	7,202,751	63.9	3,393,895	30.1	675,069	6.0	11,271,715	100.0

Data on imports obtained from Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.

TABLE III.—*United States imports for consumption of dried-egg products*

Year	Liquid equivalents of dried-yolk imports	Liquid equivalents of dried-albumen imports	Liquid equivalents of dried whole-egg imports	Total liquid equivalents	Shell-egg equivalents [1]
	Pounds	*Pounds*	*Pounds*	*Pounds*	*Dozens*
1920	6,413,282	19,852,949	9,707,815	35,974,046	30,834,016
1921	8,573,913	19,294,725	7,143,024	35,011,662	30,009,139
1922	7,885,088	24,009,247	10,722,677	42,617,012	36,527,824
1923	3,416,424	19,898,902	5,694,029	29,009,355	24,864,451
1924	8,834,923	21,511,830	5,674,651	36,021,404	30,874,607
1925	12,300,607	22,992,759	8,999,874	44,293,240	37,964,550
1926	12,014,587	25,242,283	5,623,689	42,880,559	36,753,715
1927	7,059,945	24,585,955	3,140,518	34,786,418	29,816,078
1928	9,616,229	20,089,819	3,042,600	32,748,648	28,069,468
1929	12,022,375	29,006,083	5,263,562	46,292,020	39,677,741
1930	13,620,286	25,199,082	4,739,693	43,559,061	37,335,271
1931	12,515,747	18,108,300	7,385,284	38,009,331	32,578,496
1932	1,598,080	9,313,267	78,968	10,990,315	9,420,001
1933	3,594,488	6,381,368	37,074	10,012,930	8,582,266
1934	5,103,927	2,938,476	4,038	8,046,441	6,896,752
1935	8,695,861	13,695,128	2,148,872	24,539,861	21,033,566
1936	10,783,403	17,214,393	1,903,078	29,900,874	25,628,588
1937	11,937,988	20,761,733	2,144,388	34,844,109	29,865,526

[1] The fourth column has been divided by 1.1667, the pounds of liquid egg in 1 dozen shell eggs.

TABLE IV.—*United States imports of dried-egg products:*[1] *general imports, 1924–33; imports for consumption, 1934–37*

[Data for fig. 11]

DRIED YOLK

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total
	1,000 pounds	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*	*1,000 pounds*
1924	271	96	60	10	-------	85	649	1,053	1,289	224	341	29	4,107
1925	105	45	50	13	40	442	968	1,595	972	945	306	202	5,683
1926	309	181	231	23	68	205	617	344	820	616	586	398	4,398
1927	324	272	122	104	58	207	330	445	389	301	594	379	3,525
1928	234	138	137	100	277	162	679	584	668	727	427	331	4,464
1929	205	175	113	58	324	838	1,027	1,309	996	617	430	514	6,606
1930	346	176	334	709	915	446	814	713	483	861	547	301	6,645
1931	432	196	73	261	473	914	1,333	158	38	-------	64	22	3,964
1932	34	11	23	-------	27	210	103	133	61	74	211	306	1,193
1933	326	176	78	11	37	78	802	593	285	85	47	22	2,540
1934	161	161	145	120	188	200	227	258	243	234	220	163	2,320
1935	253	238	254	166	272	588	391	394	377	360	369	291	3,953
1936	364	243	359	310	337	555	631	504	431	424	330	414	4,902
1937	479	336	526	419	422	604	682	587	394	491	231	255	5,426

DRIED ALBUMEN

1924	84	33	8	2	5	178	664	927	556	104	116	91	2,768
1925	134	133	67	73	49	344	803	1,003	584	452	217	330	4,189
1926	293	154	180	180	146	148	455	453	497	419	300	274	3,499
1927	263	112	319	334	187	246	294	459	200	203	157	186	2,960
1928	176	129	128	109	157	163	321	250	207	323	226	182	2,371
1929	334	161	112	114	215	453	538	548	173	427	349	587	4,011
1930	202	177	495	356	246	265	396	286	232	161	156	180	3,152
1931	159	121	143	74	47	264	788	106	32	56	83	119	1,992
1932	75	90	78	60	54	182	156	198	165	146	74	180	1,458
1933	267	129	60	11	14	22	22	71	27	7	31	-------	661
1934	22	13	24	10	15	22	49	59	43	36	60	50	403
1935	92	114	153	136	111	236	159	184	199	174	157	161	1,876
1936	222	122	166	135	136	198	215	279	269	257	250	167	2,416
1937	320	183	239	325	159	195	205	265	298	353	149	153	2,844

DRIED WHOLE EGG

1924	-------	47	5	44	336	112	57	14	1	64	162	1,241	2,083
1925	32	34	135	[2]	84	60	185	99	46	150	505	125	1,455
1926	37	7	35	21	32	124	134	-------	53	49	131	54	677
1927	335	333	3	-------	36	3	-------	51	11	143	18	29	962
1928	7	5	9	-------	68	234	1,138	22	16	241	80	15	1,835
1929	-------	54	72	11	263	220	6	74	607	19	219	97	1,642
1930	14	109	120	236	254	84	56	275	-------	27	27	27	1,229
1931	23	-------	-------	66	37	283	407	-------	100	2	16	-------	934
1932	11	-------	7	-------	-------	-------	2	-------	-------	-------	[2]	-------	20
1933	-------	6	-------	-------	1	10	-------	[2]	-------	-------	-------	-------	17
1934	1	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	-------	1
1935	-------	[2]	13	66	194	104	37	8	16	28	48	88	602
1936	64	28	16	64	27	14	53	4	18	105	47	93	533
1937	55	31	107	84	66	23	16	38	27	99	20	35	601

[1] Beginning with 1934, imports are shown as for consumption.
[2] Less than 500 pounds.

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TABLE V.—*Total imports for consumption of dried-egg products, and spread between Shanghai and United States shell-egg prices, 1923–37*

[Data for Fig. 12]

Year	Total imports for consumption [1]		Average Shanghai wholesale price of shell eggs plus United States tariff protection [2]	Average farm price of shell eggs in United States [3]	Amount United States egg prices are above or below Shanghai egg prices	
	Pounds	Changes from previous year			Cents per dozen	Changes from previous year
		1,000 pounds	*Cents per dozen*	*Cents per dozen*		*Cents*
1923	5,873,763		18.6	18.9	0.3	
1924	8,552,238	2,678	17.9	17.0	−.9	−1.2
1925	11,261,851	2,710	18.9	22.1	3.2	4.1
1926	10,494,286	−768	17.7	21.9	4.2	1.0
1927	7,456,702	−3,038	18.1	16.5	−1.6	−5.8
1928	7,975,312	519	19.1	21.1	2.0	3.6
1929	10,912,539	2,937	18.1	21.6	3.5	1.5
1930	10,970,613	58	15.5	17.4	1.9	−1.6
1931	10,238,272	−732	13.1	12.6	−.5	−2.4
1932	2,024,310	−8,214	15.5	7.5	−8.0	−7.5
1933	2,518,403	494	14.8	8.0	−6.8	1.2
1934	2,723,629	205	14.6	11.4	−3.2	3.6
1935	6,430,634	3,707	14.8	18.7	3.9	7.1
1936	7,850,558	1,420	15.0	15.5	.5	−3.4
1937	8,871,100	1,021	16.3	16.9	.6	.1

[1] Taken from table 2 on p. 7.
[2] Taken from table 13 on p. 26. To the average Shanghai price of shell eggs during March through June has been added the United States tariff on dried whole egg in terms of cents-per-dozen equivalent. This protection has amounted to 5.9 cents per dozen through 1930, 6.1 cents during 1931, and 8.8 cents per dozen thereafter.
[3] Taken from table 13 on p. 26.

TABLE VI.—*United States farm shell-egg prices, March–June, and prices of frozen-egg products, April through March of the following year, 1926–36*

[Data for fig. 13]

Year	Frozen-egg prices [1] April through March of the following year						United States farm egg price. March June average [2]	
	Whole		Albumen		Yolk			
	Cents per pound	Changes from previous year	Cents per pound	Changes from previous year	Cents per pound	Changes from previous year	Cents per pound	Changes from previous year
		Cents		*Cents*		*Cents*		*Cents*
1926	26.8		23.7		30.1		25.0	
1927	22.7	−4.1	15.5	−8.2	32.1	2.0	19.7	−5.3
1928	25.8	3.1	12.4	−3.1	39.0	6.9	23.6	3.9
1929	26.6	.8	16.2	3.8	39.6	.6	25.4	1.8
1930	22.0	−4.6	15.5	−.7	30.1	−9.5	20.4	−5.0
1931	15.9	−6.1	13.2	−2.3	20.7	−9.4	15.2	−5.2
1932	12.4	−3.5	9.2	−4.0	17.5	−3.2	10.4	−4.8
1933	12.3	−.1	7.9	−1.3	19.8	2.3	10.6	.2
1934	15.1	2.8	10.2	2.3	21.2	1.4	13.6	3.0
1935	19.5	4.4	14.2	4.0	25.7	4.5	20.2	6.6
1936	18.6	−.9	12.4	−1.8	25.6	−.1	17.8	−2.4

[1] Taken from table 28 on p. 44.
[2] Taken from table VIII on p. 67.

TABLE VII.—*Average annual prices of domestically produced frozen yolk and albumen, and annual prices of imported dried yolk and albumen, 1926–36*

[Data for fig. 14]

Year	Frozen-egg prices [1]				Dried-egg prices [2]			
	Yolk		Albumen		Yolk		Albumen	
	Per pound	Changes from previous year	Per pound	Changes from previous year	Per pound	Changes from previous year	Per pound	Changes from previous year
	Cents	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*	*Cents*
1926	29.0		24.2		60.2		101.1	
1927	31.1	2.1	18.0	−6.2	82.3	22.1	90.0	−11.1
1928	38.1	7.0	12.9	−5.1	77.7	−4.6	81.8	−8.2
1929	39.4	1.3	14.4	1.5	79.3	1.6	78.7	−3.1
1930	32.9	−6.5	16.1	1.7	67.8	−11.5	68.9	−9.8
1931	22.7	−10.2	14.0	−2.1	53.3	−14.5	61.8	−7.1
1932	17.8	−4.9	10.1	−3.9	47.8	−5.5	82.6	20.8
1933	19.2	1.4	7.9	−2.2	43.2	−4.6	81.2	−1.4
1934	20.7	1.5	9.5	1.6	44.6	1.4	88.1	6.9
1935	25.2	4.5	13.8	4.3	52.5	7.9	85.2	−2.9
1936	24.9	−.3	12.3	−1.5	51.6	−.9	79.7	−5.5

[1] Taken from table 28 on p. 44.
[2] Taken from tables 16 and 17 on pp. 28.

TABLE VIII.—*Average farm egg prices for Texas, Oklahoma, Kansas, and Missouri, March–June, and United States average farm egg prices, March–June, 1911–37*

[Data for fig. 16]

Year	Average farm egg prices for Texas, Oklahoma, Kansas, and Missouri		Average farm egg prices for United States	
	Cents per dozen	Changes from previous year	Cents per dozen	Changes from previous year
		Cents		*Cents*
1910	16.4		19.0	
1911	12.2	−4.2	14.9	−4.1
1912	15.6	3.4	18.0	3.1
1913	14.3	−1.3	16.8	−1.2
1914	15.9	1.6	18.2	1.4
1915	14.4	−1.5	16.4	−1.8
1916	15.8	1.4	18.3	1.9
1917	26.4	10.6	28.5	10.2
1918	27.4	1.0	30.4	1.9
1919	33.1	5.7	36.2	5.8
1920	32.2	−.9	37.6	1.4
1921	17.8	−14.4	21.7	−15.9
1922	16.9	−.9	20.2	−1.5
1923	18.9	2.0	22.4	2.2
1924	17.0	−1.9	20.1	−2.3
1925	22.1	5.1	24.8	4.7
1926	21.9	−.2	25.0	.2
1927	16.5	−5.4	19.7	−5.3
1928	21.1	4.6	23.6	3.9
1929	21.6	.5	25.4	1.8
1930	17.4	−4.2	20.4	−5.0
1931	12.6	−4.8	15.2	−5.2
1932	7.5	−5.1	10.4	−4.8
1933	8.0	.5	10.6	.2
1934	11.4	3.4	13.6	3.0
1935	18.7	7.3	20.2	6.6
1936	15.5	−3.2	17.8	−2.4
1937	16.9	1.4	18.9	1.1

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TABLE IX.—*Cold-storage holdings of shell eggs, August 1; egg receipts at 4 principal markets, January–July; and storage margin on shell eggs the previous year*

[Data for Fig. 17]

Year	Cold-storage holdings of shell eggs on Aug. 1 [1]		Egg receipts at 4 markets January–July [2]		Estimated storage margin on shell eggs the previous year [3]
	1,000 cases	Changes from previous years	1,000 cases	Changes from previous year	
		1,000,000 cases		*1,000 cases*	*Cents per dozen*
1920	6,872		9,454		
1921	7,605	0.7	10,660	1,206	10.5
1922	10,161	2.6	11,910	1,250	8.3
1923	10,509	.3	11,971	61	1.8
1924	9,267	−1.2	11,254	−717	2.6
1925	10,024	.7	11,256	2	12.9
1926	9,845	−.2	10,985	−271	2.5
1927	10,746	.9	11,916	931	4.6
1928	10,496	−.2	11,699	−217	8.4
1929	8,962	−1.5	11,205	−494	.3
1930	11,198	2.2	11,702	497	8.0
1931	9,504	−1.7	11,610	−92	−4.3
1932	6,431	−3.1	9,452	−2,158	.3
1933	9,507	3.1	10,733	1,281	9.1
1934	8,961	−.5	9,767	−966	2.1
1935	7,947	−1.1	9,071	−696	5.0
1936	7,335	−.6	9,993	922	−1.4

[1] Market News Service, Bureau of Agricultural Economics.
[2] Division of Statistical and Historical Research, Bureau of Agricultural Economics. The estimated margin between the average seasonal price at New York City of Storage Packed Firsts, March–June, and the average seasonal price at New York City of Refrigerator Firsts, September–January.

TABLE X.—*United States average October–December farm price of eggs, nonagricultural income, and August 1 cold-storage holdings of shell eggs, 1921–36*

[Data for fig. 18]

Year	United States farm egg prices			Index of nonagricultural income			Cold-storage holdings of shell eggs		
	October–December	Logarithms	Change from previous year	October–December	Logarithms	Change from previous year	Aug. 1	Logarithms	Change from previous year
	Cents per dozen			*Index numbers*			*1,000,000 cases*		
1920	61.5	1.7889		79.1	1.8982		6.9	0.8388	
1921	46.8	1.6702	−0.1187	72.1	1.8579	−0.0403	7.6	.8808	0.0420
1922	41.8	1.6212	−.0490	82.1	1.9143	.0564	10.2	1.0086	.1278
1923	41.9	1.6222	.0010	90.2	1.9552	.0409	10.5	1.0212	.0126
1924	44.6	1.6493	.0271	90.6	1.9571	.0019	9.3	.9685	−.0527
1925	44.2	1.6454	−.0039	100.1	2.0004	.0433	10.0	1.0000	.0315
1926	43.1	1.6345	−.0109	101.6	2.0069	.0065	9.8	.9912	−.0088
1927	40.2	1.6042	−.0303	100.7	2.0030	−.0039	10.7	1.0294	.0382
1928	39.1	1.5922	−.0120	105.3	2.0224	.0194	10.5	1.0212	−.0082
1929	42.8	1.6314	.0392	107.3	2.0306	.0082	9.0	.9542	−.0670
1930	28.3	1.4518	−.1796	94.5	1.9754	−.0552	11.2	1.0492	.0950
1931	24.9	1.3962	−.0556	78.9	1.8971	−.0783	9.5	.9777	−.0715
1932	25.6	1.4082	.0120	63.1	1.8000	−.0971	6.4	.8062	−.1715
1933	22.1	1.3444	−.0638	66.9	1.8254	.0254	9.5	.9777	.1715
1934	26.4	1.4216	.0772	72.6	1.8609	.0355	9.0	.9542	−.0235
1935	28.9	1.4609	.0393	79.7	1.9015	.0406	7.9	.8976	−.0566
1936	30.2	1.4800	.0191	94.4	1.9750	.0735	7.3	.8633	−.0343

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TABLE XI.— *United States average annual farm price of eggs, annual receipts of eggs at 4 markets, nonagricultural income, and January 1 cold-storage holdings of shell plus frozen eggs, 1920–36*

[Data for fig. 19]

Year	United States farm price of eggs			Egg receipts at 4 markets			Index of nonagricultural income			Cold-storage holdings of shell plus frozen eggs		
	Average annual	Logarithms	Changes from previous year	Annual total	Logarithms	Changes from previous year	Average annual	Logarithms	Changes from previous year	Jan. 1	Logarithms	Changes from previous year
	Cents per doz.			*Million*						*1,000*		
1919	44.7	1.6503	----------	14.0	1.1461	----------	71.3	1.8531	----------	997	2.9987	----------
1920	47.8	1.6794	0.0291	12.2	1.0864	−0.0597	82.5	1.9164	0.0633	2,093	3.3208	0.3221
1921	33.1	1.5198	−.1596	14.2	1.1523	.0659	72.9	1.8627	−.0537	1,189	3.0752	−.2456
1922	28.1	1.4487	−.0711	15.2	1.1818	.0295	76.1	1.8814	.0187	1,439	3.1581	.0829
1923	29.8	1.4742	.0255	15.8	1.1987	.0169	87.2	1.9405	.0591	1,962	3.2927	.1346
1924	30.3	1.4814	.0072	14.6	1.1644	−.0343	90.5	1.9566	.0161	2,844	3.4539	.1612
1925	33.7	1.5276	.0462	14.8	1.1703	.0059	96.2	1.9832	.0266	1,659	3.2198	−.2341
1926	31.5	1.4983	−.0293	14.8	1.1703	0	100.4	2.0017	.0185	2,652	3.4236	.2038
1927	28.2	1.4502	−.0481	15.4	1.1875	.0172	101.8	2.0078	.0061	2,056	3.3130	−.1106
1928	30.3	1.4814	.0312	15.4	1.1875	0	104.1	2.0174	.0096	2,225	3.3473	.0343
1929	32.1	1.5065	.0251	14.9	1.1732	−.0143	107.0	2.0294	.0120	3,020	3.4800	.1327
1930	25.1	1.3997	−.1068	15.4	1.1875	.0143	100.4	2.0017	−.0277	2,237	3.3497	−.1303
1931	18.6	1.2695	−.1302	15.3	1.1847	−.0028	85.5	1.9320	−.0697	4,271	3.6305	.2808
1932	16.0	1.2041	−.0654	13.0	1.1139	−.0708	67.6	1.8300	−.1020	3,738	3.5726	−.0579
1933	15.3	1.1847	−.0194	13.9	1.1430	.0291	63.0	1.7993	−.0307	1,740	3.2406	−.3320
1934	18.4	1.2648	.0801	12.8	1.1072	−.0358	71.9	1.8567	.0574	2,486	3.3955	.1549
1935	24.1	1.3820	.1172	12.5	1.0969	−.0103	77.0	1.8865	.0298	2,502	3.3983	.0028
1936	23.0	1.3617	−.0203	13.3	1.1238	.0269	87.0	1.9395	.0530	2,951	3.4700	.0717

Bureau of Agricultural Economics: United States Farm Price of Eggs. Egg Receipts at Four Markets. Cold Storage Holdings of Shell Plus Frozen Eggs.
Agricultural Adjustment Administration: Index of Nonagricultural Income.

APPENDIX B

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APPENDIX C

PATENTS CONCERNING THE DRYING OF EGGS

No. 50,421. Issued: Oct. 10, 1865. Patentee: Charles A. LaMont.

A process of drying eggs on revolving discs. This apepars to be a patent on the basic art. No drawings or description of method of revolving the discs.

No. 51,084. Issued: Nov. 21, 1865. Patentee: T. H. Quick.

A drum-type drier with heat applied inside drum by steam or hot water. Drum revolves in a pan of liquid egg. No provision for automatically removing dried film of liquid egg.

No. 51,263. Issued: Nov. 28, 1865. Patentee: Charles A. LaMont, assignor to C. A. LaMont and David A. Burr.

A process of preparing desiccated and hardened eggs into flakes or particles, readily soluble in water, by drying a batter of beaten eggs in a thin film upon revolving plates by exposure to heated air at a temperature just exceeding the highest degree of heat that eggs can be afterwards subjected to, or by drying by means of a blast of air upon a thin spray.

No. 68,834. Issued: Sept. 17, 1867. Patentee: L. H. Boole.

This patent covers a process of drying liquid egg without the application of heat, by means of a blast of room-temperature air over a thin layer or film of liquid egg, until most of the water has been removed. The liquid egg is then compressed to squeeze out the balance of the water.

No. 75,242. Issued: Mar. 10, 1868. Patentee: Joseph Brakely.

A process whereby eggs can be dried in the shell by means of a vacuum. Eggs are placed in a tank and the air pumped out until the eggs are dry.

No. 131,507. Issued: Sept. 24, 1872. Patentee: A. R. Davis.

This patent covers a process of partially drying eggs by any suitable means, and then adding sugar to act as a preservative.

No. 167,587. Issued: Sept. 7, 1875. Patentee: W. O. Stoddard, New York City.

A process of drying liquid egg on a rotating drum with the aid of a blast of air. This patent does not cover the type or construction of the rotary drum.

No. 167,801. Issued: Sept. 14, 1875. Patentee: W. O. Stoddard, New York City.

A process of applying heat to a drum for drying liquid egg. This seems to be patenting the method of the drum drier, and leaving to later patents a description of various ideas and appended devices.

No. 169,311. Issued: Oct. 26, 1875. Patentee: W. O. Stoddard, New York City.

Rotary drum machine for drying liquid egg, heated by air on outside of drum.

No. 172,611. Issued: Jan. 1, 1876. Patentee: P. Cooper, New York City, assignor to C. A. LaMont, Turner's, N. Y.

A method of using thin discs or plates mounted on a shaft for desiccating eggs. No mention of heat applied.

No. 184,186. Issued: Nov. 7, 1876. Patentee: W. O. Stoddard, assignor to American Egg Co., New York City.

A design for an improved liquid egg container. This container is a trough attached to which is a wooden apron the purpose of which is to apply the liquid egg on a rotary drum, heated internally, in an improved manner.

No. 184,187. Issued: Nov. 7, 1876. Patentee: W. O. Stoddard, assignor to American Egg Co., New York City.

This patent covers an improved drum for egg-drying. A shield is built outside and close to the drum with provisions for an inlet in the bottom and exhaust at the top so that hot-air blasts are confined near the surface of the drum.

No. 184,188. Issued: No. 7, 1876. Patentee: W. O. Stoddard, assignor to American Egg Co., New York City.

An improved apparatus for effecting an even uniform blast of air for drying eggs.

No. 184,192. Issued: Nov. 7, 1876. Patentee: W. O. Stoddard and Isadore Waltz, assignors to American Egg Co., New York City.

A method of drying liquid egg on a rotating drum which is enclosed in a vacuum.

No. 184,219. Issued: Nov. 7, 1876. Patentee: W. O. Stoddard, assignor to American Egg Co., New York City.

A rotating drum for drying liquid egg, ventilated interiorly in such a manner that the surface of the drum will have a lower temperature than the blasts of hot air on its outer surface.

No. 184,479. Issued: Nov. 21, 1876. Patentee: Charles Peck.

In order to prevent the dried eggs from souring or becoming rancid, this patent covers the mixing of sugar with the liquid egg before being dried. No method or machine for drying purposes is included in this patent.

No. 190,927. Issued: May 15, 1877. Patentees: W. O. Stoddard, New York City, and H. Flint, St. Louis, Mo.

An apparatus for desiccating eggs, etc., the combination, with drying chamber, of a suction blast, drying-case and endless belt with scrapers to remove the dried material.

No. 190,640. Issued: May 8, 1877. Patentee: W. O. Stoddard, New York City.

An improvement on Patent No. 184,219. This patent covers a process of cooling the liquid egg while it is being dried on a rotary drum so that the egg oil is not liberated in the process of drying.

No. 233,750. Issued: Oct. 26, 1880. Patentee: H. Halvorson.

A method of preparing dried eggs in which granulated hard-boiled eggs, mixed with liquid egg, are dried on a screen. More liquid egg is added and dried, ad infinitum.

No. 235,039. Issued: Apr. 9, 1880. Patentee: C. E. Stoddard, Chicago, Ill.

A rotary drum made of finely woven wire with a brush attached in such a manner as to brush or scrape off the dried film of egg. No mention is made of heat being applied.

No. 236,598. Issued: Jan. 11, 1881. Patentee: C. H. Kirkham.

This patent covers the mixing of a farinaceous material such as cornstarch, wheat flour, rice flour, farina, etc., in the form of a paste with liquid egg before drying. The best proportion is stated to be 1 ounce of paste to the liquid of 12 eggs. The purpose of the addition of the farinaceous material is to make the dried product more easily soluble in warm or cold water.

No. 239,722. Issued: Apr. 5, 1881. Patentee: Lydia J. Cadwell, Chicago, Ill.

An endless belt apparatus for desiccating eggs.

No. 283,618. Issued: Aug. 21, 1883. Patentee: C. A. LaMont.

A method of preventing deterioration by mixing small quantities of salt with liquid egg before drying to prevent the dried product from becoming rancid. No mention of a machine or method for drying.

No. 294,849. Issued: Mar. 11, 1884. Patentee: Lydia J. Cadwell, Chicago, Ill.

An apparatus for drying eggs on an endless belt and agitating, crushing, etc., the material while it is being dried on the belt.

No. 504,535. Issued: Sept. 5, 1893. Patentee: C. E. McClure.

The first real patent on the machinery for a drum type egg drier. It describes the construction of the drier rather completely. All previous patents on the drum type drier have been very indefinite as to its construction, and some patents did not include drawings at all.

No. 651,720. Issued: June 12, 1900. Patentee: J. Mecredy.

A process of adding salt and sodium phosphate ($Na_2P_2O_5$) to liquid egg, then either partially or completely drying this mixture. The salt and sodium phosphate act as preservatives.

No. 666,711. Issued: Jan. 29, 1901. Patentee: R. Stauf, Posen, Germany.

This appears to be the earliest patent on a spray device. Was not patented specifically for eggs, but eggs are mentioned as one of the products which can be dried in this machine. The liquid egg is sprayed upward in a chamber, aided by a forced draft of hot air. In the top of the chamber is a partition which divides the sprayed material and diverts it into two adjacent chambers in which the material falls.

No. 666,859. Issued: Jan. 29, 1901. Patentee: E. M. Bosley, St. Louis, Mo.

An egg drying apparatus that fills a four-story building. Liquid egg placed in large shallow pans for drying, and air, heated in the basement, is pumped to each floor and circulates around the pans.

No. 677,902. Issued: July 9, 1901. Patentee: W. O. Stoddard, Jr., of Madison, N. J.; assignor to Pure Food Co. of New Jersey.

This patent covers a complete factory for egg-drying. Includes a machine for breaking and mixing the yolk and albumen, applying the batter on a very large drum, heating the air, applying the hot air blasts to the drum, and removing the dried product from the drum.

No. 704,592. Issued: July 15, 1902. Patentee: P. B. Taylor, Newark, N. J., assignor to Pure Food Co. of New Jersey.

An improved device called a coating tray for applying liquid egg to a rotary drum.

No. 704,977. Issued: July 15, 1902. Patentee: P. B. Taylor, Newark, N. J., assignor to Pure Food Co., of New Jersey.

An improved means of removing a dried film of egg from a rotary drum by means of many small scrapers.

No. 806,747. Issued: Dec. 5, 1905. Patentee: J. C. Mclachlan, Chicago, Ill., assignor to International Desiccating Co. of Chicago, Ill.

A spray drier for several products among which eggs are listed. Liquid is sprayed from the top of a tall tank or drum.

No. 865,342. Issued: Sept. 3, 1907. Patentee: J. M. Hussey, Cambridge, Mass.

A machine for drying whole egg, yolk, or albumen on quite a long endless belt. The belt passes through a heated duct. The dried product is not removed from the belt until 10 to 15 layers or applications have been dried, the result being laminated flakes.

No. 866,586. Issued: Sept. 17, 1907. Patentee: J. M. Hussey, Cambridge, Mass.

This patent covers the holding of liquid egg at 32° F., and applying it to a carrier (probably an endless belt) which enters an extended heating chamber.

Nos. 916,138 and 916,139. Issued: Mar. 23, 1909. Patentee: A. Fullerton, assignor to National Bakers' Egg Co., Sioux City, Iowa.

Both patents are improvements on applying the liquid egg to a conventional endless belt for drying.

No. 951,249. Issued: Mar. 8, 1910. Patentee: H. J. and S. C. Keith, Jr., assignors to H. J. Keith & Co., Boston, Mass.

An improved method of feeding liquid egg on to a rotary drum so that a uniformly thin film will be applied.

No. 957,061. Issued: May 3, 1910. Patentee: J. M. Hussey, Wichita, Kans.

An improvement on Patent No. 865,342.

No. 1,028,005. Issued: May 28, 1912. Patentee: Con Driscoll, assignor to Frank Prevost.

This patent covers the addition of sugar and cream to liquid egg before drying. No process, machinery, or method claimed for drying. The purpose of this patent is to produce a product that can be packaged and retailed in stores for use in home-cooking of pastries, etc.

No. 1,076,147. Issued: Oct. 21, 1913. Patentee: Frank Prevost.

This patent covers the addition of sugar to albumen before drying. In this and the preceding patent, the sugar is added as a preservative. No process or machine for the drying operation is claimed.

No. 1,078,848. Issued: Nov. 18, 1913. Patentees: C. E. Gray and A. Jensen.

This patent was issued for an apparatus for recovering constituent solids of liquids in the form of a dry powder. It combines a desiccating chamber, means for atomizing the liquid centrally into said chamber and for forcing heated air into the chamber tangentially at the side to produce cyclonic currents of air in the chamber; a second chamber, which receives air from desiccating chamber, contains a liquid spraying device and liquid heater.

No. 1,100,973. Issued: June 23, 1914. Patentee: Toyoyory Hara, California.

A process of separating the yolk and albumen and beating each in order to create as nearly as possible a homogeneous mass. The yolk and albumen are then mixed together and spread on porcelain plates in very thin layers. These plates are then placed in a dark room which is held at a temperature of 110° F. until the liquid egg is dry. The patentee claims that the room should be dark because the action of light on the eggs causes a change in color.

No. 1,107,784. Issued: Aug. 18, 1914. Patentee: C. E. Gray, one-half interest assigned to A. Jensen, California.

This patent covers on apparatus consisting of a cyclone drying chamber in which the heated air moves centripetally and the drying material, after being atomized, moves centrifugally through and in opposition to the air current.

No. 1,158,477. Issued: Nov. 2, 1915. Patentee: A. L. Galusha, assignor to H. J. Keith Co., Boston, Mass.

An apparatus consisting of a series of flat boards attached to an endless conveyor which is caused to zigzag through the drying chamber in order to achieve great lineal travel in comparison to the size of the drying chamber. The egg batter is spread on the boards in thin films and a series of baffle boards forces the heated air into contact with the liquid egg.

No. 1,163,873. Issued: Dec. 14, 1915. Patentee: H. E. Thornburgh.

A process of heating eggs in the shell to a temperature just below the coagulation point of albumen in order to kill bacteria in the egg. Then the eggs are broken out and dried. No claim is made on the drying process. This patent has in view the reduction of rancidity and increasing the keeping qualities of the finished product.

No. 1,176,078. Issued: Mar. 21, 1916. Patentees: L. M. Mick and G. Weiss, assignor to G. Weiss.

This patent covers a device consisting of many large discs used for drying surfaces inside a large heated drum. Hot air is blown in the drum and over the discs. A series of scrapers are provided for removing the dried film of egg. This patent is called "Process of and Apparatus for Drying or desiccating Liquids," but mentions eggs as a suitable product to be dried. The patents above specify that the machine or attachment is for the purpose of drying eggs.

No. 1,183,098. Issued: May 16, 1916. Patentees: O. E. and I. S. Merrell, assignors to Merrell-Soule Co., Syracuse, N. Y.

A design for a spray nozzle to be used in desiccating eggs.

No. 1,203,983. Issued: Nov. 7, 1916. Patentee: G. E. Conant, assignor of one-half interest to J. Decker, Jr., Montclair, N. H.

This patent covers a dried-egg product prepared by mixing sugar or malt sugar with yolk, albumen or whole egg, then drying and moulding into a tablet to be sold by retailers for household use. It describes the drum method of drying as the best, preferably drum drying in a vacuum.

No. 1,226,999. Issued: May 22, 1917. Patentee: T. C. Primaverse.

A method to prevent deterioration and rancidity of dried-egg products by which whole egg is mixed with 4 percent (by weight) of lemon juice, and drying at 75° or 80° F.

No. 1,330,746. Issued: Feb. 10, 1920. Patentee: A. D. Robinson, St. Louis, Mo.

An improved device for applying liquid egg to an endless belt which passes through a heated chamber.

No. 1,330,747. Issued: Feb. 10, 1920. Patentee: A. D. Robinson, Logan, W. Va.

An improvement on the conventional endless belt type of drier whereby special means are provided to deflect the heated air on to the moving belt in order to accelerate the rate of drying.

No. 1,563,953. Issued: Dec. 1, 1925. Patentee: C. E. Barnhill.

Process of drying albumen by dipping a fine wire mesh or screen in liquid albumen, heating and removing the dried product by a rotating brush.

No. 1,595,778. Issued: Aug. 10, 1926. Patentee: U. S. Harkson, Portland, Oreg.

An apparatus consisting of a series of shallow drying pans placed in a rack over a slowly flowing current of water heated to below the coagulation point of the liquid egg. The bottom of the egg pan comes into contact with the water, thereby heating and drying the egg material.

No. 1,639,549. Issued: Aug. 16, 1927. Patentee: A. J. Bellamy, assignor to Egg Patents, Limited, London, England.

This patent covers an egg product prepared by the addition of 2.5 to 15 percent glycerine to liquid egg and partially drying. The egg product is to be sold in the form of a paste, the glycerine acting as a preservative.

No. 1,797,055. Issued: Mar. 17, 1931. Patentee: F. H. Douthitt, Chicago, Ill., one-half interest assigned to C. E. Gray, Oakland, Calif.

An improvement on Patents No. 1,178,848, No. 1,107,784, and No. 1,829,477.

No. 1,818,212. Issued: Aug. 11, 1931. Patentees: A. K. Epstein and B. R. Harris, Chicago, Ill.

A process for preparing liquid egg albumen for drying by allowing the material to ripen to a point at which it is substantially neutral or slightly acid to phenolphthalein, but arresting the ripening action before the material becomes acid to litmus. Drying in pans or on a drum is recommended.

No. 1,818,213. Issued: Aug. 11, 1931. Patentees: Albert K. Epstein and Benjamin R. Harris, Chicago, Ill.

This patent covers the addition of sucrose or some similar hydrocarbon to liquid albumen immediately upon separation from the yolk. The albumen is then allowed to ripen and is then dried by the conventional pan method. The addition of sucrose enables the dried product to foam better when used for pastries, etc.

No. 1,818,214. Issued: Aug. 11, 1931. Patentees: A. K. Epstein and B. R. Harris, Chicago, Ill.

A process of inoculating liquid albumen with a specific acid-forming organism and allowing fermentation to proceed to a point where the liquid albumen is acid to phenolphthalein but alkaline to litmus. The purpose of this patent

is to hasten the ripening period and to obtain a fermented albumen of the proper type and consistency so that the dried product, using the pan method, will be as uniform and suitable as possible for use in food products.

No. 1,829,477. Issued: Oct. 27, 1931. Patentee: F. H. Douthitt, Chicago, Ill.

An improvement on Patents No. 1,078,848 and No. 1,107,784.

No. 1,891,887. Issued: Dec. 20, 1932. Patentee: Forest H. Clickner, assignor to Endowment Foundation, of New Jersey.

A process in which liquid albumen is diluted with water to remove insoluble or unemulsifiable materials prior to desiccation by the spray method.

No. 1,897,775. Issued: Feb. 4, 1933. Patentee: Samuel Tranin, assignor to Tranin Egg Products Co., Kansas City, Mo.

This patent covers a dried-egg product consisting of 6 parts liquid egg yolk, 1.5 parts liquid butter fat and 2.5 parts dried milk. This mixture is then dried and is particularly suited for use in manufacturing ice cream.

No. 1,907,801. Issued: May 9, 1933. Patentee: Benjamin R. Harris, Chicago, Ill.

A process for hydrating desiccated materials, particularly dried eggs, in such a manner as to preserve the egg material bacteriologically. A crystalloid such as salt, sucrose, dextrose, etc., is added in sufficient quantity in itself to preserve the product bacteriologically, but the acid increasing the hydrogenion concentration sufficient to protect the material bacteriologically. Osmotic pressure is increased, which thereby increases the rate of hydration.

No. 1,951,889. Issued: Mar. 20, 1934. Patentee: Sam Tranin, Kansas City, Mo.

A process of freezing or drying whole egg, yolk or albumen by incorporating carbon dioxide with each particle of the sprayed material. The materials are sprayed into very fine particles in an atmosphere of carbon dioxide. Each particle absorbs a sufficient quantity of the carbon dioxide to maintain the original alkalinity of the fresh egg, and to also act as a preservative against rancidity.

No. 1,961,770. Issued: June 5, 1934. Patentee: A. H. Leach, assignor of one-half interest to Carl Ruh, Oakland, Calif.

This patent covers an apparatus consisting of a large disc shaped like a washer which revolves in a housing and on which the liquid egg is spread in a fine film. Hot air is blown inside the housing in the opposite direction to the rotation of the drying disc. This patent seems to be confined specifically to eggs.

Nos. 1,996,800 and 1,996,801. Issued: Apr. 9, 1935. Patentee: Norman C. Fischer.

A process by which egg albumen is liquified with an acid before drying. The purpose of this process is to reduce the time of ripening or fermenting the albumen before drying.

No. 2,006,799. Issued: July 2, 1935. Patentees: A. K. Epstein, B. R. Harris, M. C. Reynolds, and W. M. Sternberg, Chicago, Ill.

A process of producing dried egg albumen with improved foaming characteristics by drying the albumen below its coagulation point until most of the moisture is removed, then heating to higher than the coagulation point until practically all moisture has evaporated, and then exposing to a humid atmosphere to partially hydrate the same.

No. 2,035,673. Issued: Mar. 31, 1936. Patentee: K. Schultz, assignor to Armour and Co., Chicago, Ill.

A spray-drying apparatus designed so that heated air is admitted to the cylindrical drying chamber at the top and also through lower openings, thus preventing the drying material from coming into contact with the side walls.

No. 2,043,372. Issued: June 9, 1936. Patentee: O. E. Droege, assignor to Industrial Patents Corporation, Chicago Ill.

A method of treating liquid egg by forcing the egg material under pressure through a perforated plate cooperating with a rotatable knife. No air is allowed to mix with the egg material.

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No. 2,054,213. Issued: Sept. 15, 1936. Patentees: A. K. Balls and T. L. Swenson, dedicated to the free use of the public.

A process of thinning egg white, preparatory to drying, which comprises mixing a substance containing enterokinose with the egg albumen at a temperature between 25° C. and 40° C.

No. 2,056,082. Issued: Sept. 29, 1936. Patentee: Samuel Tranin, Kansas City, Mo.

A method of preparing liquid egg albumen for drying by adding a fermented alcoholic culture, allowing mixture to acidify, removing "scum" or the culture and chalazae, and then drying by either the pan or spray method. Resulting dried product is protected from deterioration and objectionable odors by the presence of alcohols.

No. 2,059,399. Issued: Nov. 3, 1936. Patentee: H. I. Rosner, assignor to Joe Lowe Corporation, New York City.

A process of preparing egg albumen for drying which comprises adding an edible soluble organic acid such as lactic acid to the liquid albumen until a degree of acidity is obtained of approximately pH6, then adding a soluble and non-toxic alkali such as ammonium hydroxide until a degree of alkalinity of approximately pH8.6 is obtained, and removing the scum from the surface of the mixture. Resulting albumen is suitable to pan or spray drying.

No. 2,062,387. Issued: Dec. 1, 1936. Patentees: A. K. Balls and T. L. Swenson, dedicated to the free use of the public.

The process of thinning egg albumen, before drying, which comprises mixing benzoyl-glycine with the egg albumen at a temperature not exceeding 40° C.

No. 2,073,411. Issued: Mar. 9, 1937. Patentees: A. K. Balls and T. L. Swenson, dedicated to the free use of the public.

The processing of thinning egg albumen which comprises mixing a proteolytic enzyme such as trypsin with fresh egg albumen in the proportion of one part trypsin to five thousand parts egg albumen, maintaining the mixture at a temperature favorable to the enzyme action until the thick portion of the egg albumen is thinned to a desired consistency.

No. 2,087,985. Issued: July 27, 1937. Patentees: Carl H. McCharles and Harry A. Mulvaney, Berkeley, Calif.

A method of improving the keeping and whipping qualities of liquid egg albumen which consists of adding a sufficient quantity of acid to bring the pH value to approximately 5.8, agitating the mixture in a vacuum at a temperature slightly below the coagulating point of the liquid egg albumen until the hydrogenion concentration decreases to a pH value of not more than 7.0, and then drying the mixture.